HISTORICAL REPORT

of

NEW RIVER ORDNANCE PLANT

GOVERNMENT-OWNED

HERCULES POWDER COMPANY-OPERATED

DUBLIN, VIRGINIA

DECEMBER 17, 1940 THROUGH 1945

By

HERCULES POWDER COMPANY

FOREWORD

The New River Ordnance Plant was a wartime explosives plant designed for the loading of propellant and igniter charges and the manufacture of bags therefor. It was financed by the United States Government and operated by Hercules Powder Company, Wilmington, Delaware.

The plant site was located 1 mile from Dublin, Pulaski County, Virginia; 6 miles from the town of Pulaski, the county seat of Pulaski County; 52 miles from Roanoke, the largest city in this area; and 387 miles from Wilmington, Delaware, the Home Office of the Hercules Company. The New River Plant was just 12 miles from the Radford Ordnance Works, the plant that manufactured most of the powder that was afterwards bagged at New River.

Located in the rugged foothills of the surrounding Blue Ridge and Alleghany mountains, the topography of the area is hilly and rolling -- an excellent feature for explosive safety but one that presents difficulties from the point of view of construction.

The plant was named after the New River, which body of water skirted the plant site in Pulaski County. The New River rises in North Carolina; meanders its way up to Radford, Virginia; and then suddenly cuts through the mountains between Radford and West Virginia. Its outflow is into the Kanawha River at Gauley Bridge, West Virginia, the point which terminates the 255-mile course of the New River.

The New River was discovered by Abraham Wood, the explorer in 1654, and was originally named the Woods River. (Some historians claim that Woods himself did not discover the river but that his agents, Thomas Batts and Robert Fallam, were the first white men to reach it after an expedition to this section in 1671.)

Whereas historians disagree, geologists agree that the New River is the only river on the North American Continent that flows in a general northerly direction — its terminus being due northwest of its source. This leads them to

conclude that the river is one of the oldest on the continent.

In 1750 a Dr. Thomas Walker, who had migrated to this section, changed the name Woods River to that of New River.

History does repeat itself. During the days of the American revolution, a plant was built just a few miles from the New River plant site and along the banks of the New River for the purpose of supplying our soldiers with black powder. Later in 1820, also on the banks of the river at Jackson's Ferry, a structure was erected for the manufacture of shot. The old tower, known as the Shot Tower, still stands.

The inhabitants of this section are descendants of those intrepid pioneers who had migrated to this area in search of freedom and security. They settled in this section largely because of the rich soil, abundant grazing lands, and beauty of the natural scene. Largely of Scotch-Irish ancestry, the people of this section form a solid, conservative type of American citizenry.

Although primarily supported by agriculture, the people of this section have never been adverse to industry's "setting up shop" here to keep abreast of the times. The town of Pulaski has for a long time been industrially minded. Twenty-seven industrial concerns that manufacture such varied things as textiles, furniture, chemicals, veneer, etc., are located in Pulaski.

In this immediate section are many educational institutions of high rank, such as Virginia Polytechnic Institute, the largest college in the state; Radford State Teacher's College (Women's Division of V.P.I.), Roanoke College, Hollins College, Marion College, Virginia Intermont College, and Emory and Henry College.

Pulaski County was named after Count Casimir Pulaski. He came to this country after being solicited to fight for the cause of American freedom by Benjamin Franklin. He was later killed in 1779 in the siege of Savannah.

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The following figures show the number of pounds of powder received at and shipped from the New River Ordnance Plant from 1941 through 1945.

Lbs. of Powder Received		Lbs. of Powder Shipped
	1941	
13,201,012		2,744,804
	1942	
67,675,793		49,502,644
	1943	
92,946,682		86,731,211
	1944	
104,290,051		83,101,229
	1945	
49,453,330		65,881,465
Total No. of Lbs.		
327,566,868		287,961,353

Roanoke, Virginia

Lucian D. Booth

Date January, 1946

OUTLINE
OF
NEW RIVER ORDNANCE PLANT REPORT

GOVERNMENT-OWNED

HERCULES POWDER COMPANY-OPERATED

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and busses, because it permitted them to avoid the heavy grades in the vicinity of Pulaski. A by-pass to the west of Dublin existed which connected Routes 11 and 100, permitting south-bound traffic to avoid the village of Dublin. The plant constructed a by-pass road to permit easy access of traffic from the east to the plant proper, by-passing the town of Dublin.

i. Labor and Housing

The estimated operating labor was about 4,500 people. The type of work to be performed at this plant did not require highly skilled labor, and a high percentage of women could be used. One disadvantage of this location as regards labor was that the Radford Ordnance Works had drawn heavily on the labor of this vicinity. Consequently, labor would have to be drawn from the farms and small towns within a fifty-mile radius of the plant.

Housing near the plant location was non-existent, so the prospective employees would have to commute from their existing residences. During the latter part of 1941, 75 duplex houses were constructed by the Farm Security Administration, approximately seven miles west of the plant on a site purchased outright by the Government from Charles P. McGill. The Farm Security Administration also erected 20 dormitories across Route 100 from the plant. However, they were erected too late to be of much help. As a result, most of the employees had to travel long distances by automobile or bus. Eventually a privately financed company built about 20 small houses near the plant for purchase on contract. Later, the F.H.A. discussed the idea of constructing 150 houses on the plant property. This was never realized as the result of variation of war requirements.

9. Estimates for Contract Purposes, New River Plant

At the time Hercules was called upon to design and operate the Bag

Loading Plant, the only such operations being conducted in the United States were in the Army plants at Picatinny Arsenal, New Jersey, and Curtis Bay Ordnance Depot, Maryland, and in the Navy Plant at Iona Island, New York. Those existing facilities were visited by representatives of Hercules Powder Company, and data were obtained concerning equipment and operation. Details of organization, costs of production, unit performance rates, etc., were studied for the types of ammunition being bagged at each plant.

From these studies there was prepared by the Hercules' Engineering Department, in collaboration with the Hercules' Operating Division of the Explosives Department, a preliminary tentative layout and an estimate of the cost of the plant and of operation for one year.

The original schedule for the design of the plant (and for determining the contractors' fees for construction and operation) called for the following recommended daily capacity:

No. of Loading Lines	Type of Charge	No. Charges in 24 Hrs.	Lbs. Loaded in 24 Hrs.
1	75 MM How., or equiv.	16,000	15,500
1	105 MM How., or equiv.	8,000	23,000
1	155 MM How., M1A1, or equiv.	8,000	21,000
1	155 MM How., M2, or equiv.	8,000	66,000
1	155 MM Gun, or equiv.	4,000	100,000
5 Bag Loading lines 3 Igniter Loading lines		44,000	235,500

A line consisted of two identical sets of buildings set right-and-left, having in common such Service and Administrational buildings (e.g. heating unit) as could more economically be combined without sacrifice of safety.

Each line was to be capable of loading any type of charge except stacked charges at rates specified in a designated drawing. One line was to be equipped to load stacked charges.

Facilities were to be provided, included in the plant, to manufacture propelling charge bags and igniter bags.

Storage for 30 days' supply of incoming materials and for 60 days' supply

of finished (outgoing) materials was to be provided. This storage capacity was estimated to require:

20 Warehouses for Inert (Non-explosive) Materials
3 Black Powder Magazines
20 Smokeless Powder Magazines
50 Propelling Charge Magazines

The above-mentioned daily capacity was the planned production for three 8-hour shifts, 7 days a week, with a lay-off of one shift each Sunday and a reduction of 10% efficiency on each night shift. This was equivalent to 28 days per month operation on the above-mentioned charges and rates. Planned operations for one year were limited by funds available, and production orders for 12 months following the beginning of operations were not to exceed:

1,400,000 Charges for 75 MM Howitzer
2,200,000 Charges for 105 MM Howitzer
900,000 Charges for 155 MM Howitzer, M2
492,000 Charges for 155 MM Gun, 1917

Therefore, the initial operating contract was to be based upon operating all lines one 8-hour shift per day for one year -- with provisions for increasing this rate to the maximum when and if such action might be required.

The above requirements as to number and type of buildings and loadings were changed, as given hereafter, before the contract was signed. Loading schedules were revised frequently and abruptly thereafter.

10. Contracts for the New River Plant

The United States Government entered into two primary contracts covering the New River Loading Plant. One contract was with Hercules Powder Company, Wilmington, Delaware, for the design of the plant, the technical supervision of the construction of the project, the procurement and installation of operating equipment, and the operation of the plant.

The second contract was with Mason and Hanger Company, New York, for the construction of the plant in accordance with drawings and specifications

furnished them by Hercules Powder Company.

11. Contract No. W-ORD-492, and Amendments, with Hercules Powder Company

The contract entered into between the United States Government and Hercules Powder Company, designated No. W-ORD-492, was signed December 17, 1940. This contract was for architectural and engineering services in connection with constructing and equipping a plant for the loading of propellant and igniter charges and the manufacture of bags therefor; procurement and installation of operating equipment; preparation for operation (including training of operating personnel); and operation of such plant.

The plant was to consist of 4 Propellant Charge Bag Loading lines, 2 Igniter Charge Bag Loading lines, and appropriate hoppers; bag manufacturing buildings, administration buildings, shops, railroads, roads, steam lines, air lines, electric lines, telephone lines, fencing, lighting, powerhouse, dormitories, water system, staff dwellings, cafeterias, guard quarters, fire-fighting equipment and housing thereof; and other buildings and equipment necessary or appropriate for a Bag Loading Plant of the approximate capacity aforesaid, with storage buildings adequate for about 30 days' supply of incoming material and about 60 days' production of finished product.

The contract further specified the following detailed services were to be required of the contractor:

> Make the necessary surveys and supervise test borings and foundation exploration.
>
> Prepare preliminary studies, sketches, cost estimates, and progress schedules together with approximate estimates of materials requirements.
>
> Adapt Government designs, drawings, specifications, details, and standards to the work whenever same were furnished or designated by the contracting officer.
>
> Obtain necessary permits and approvals from all local, State, and Federal authorities.

When preliminary drawings were approved by the contracting officer, prepare final designs, detailed working drawings, and specifications in accordance with Government standards necessary for the effective coordination and efficient execution of the construction work, and revise the drawings and specifications as required by the contracting officer. Final drawings were to be prepared for permanent record, inked in on linen or otherwise as directed by the contracting officer; the specifications were to be mimeographed to produce the number of copies required by the contracting officer.

Establish the governing lines, bench marks, and grades; and supervise the work designed by the contractor to insure the construction of every part of the work in accordance with the approved drawings and specifications referred to in Paragraph "e" above, and within the areas and boundaries designated for the project.

Check and approve all shop and work drawings submitted in connection with the construction work to assure that they conform with approved drawings.

Make customary field tests of concrete and concrete aggregates and other materials at the site during construction operations and inspect all materials and workmanship at the site.

When requested, consult and advise with the contracting officer on any question which may arise in connection with the work.

Upon termination of the contract or completion of the work thereunder as determined by the contracting officer, the contractor was to correct the tracings to show changes in the actual construction from the original drawings.

Perform all other architectural and engineering services within the scope of this contract, required by the contracting officer.

Technically supervise the construction of the project.

Purchase or produce and install or cause to be installed all operating equipment, jigs, fixtures, tools, and gages (including working, testing, and inspecting) necessary for a plant of this type.

Supplement No. 1 to Original Contract

This supplement, dated September 10, 1941 to the original contract was to eliminate the provision for a commanding officer to represent both the

contracting officer appointed by the Quartermaster General and the contracting officer appointed by the Chief of Ordnance; to define the scope of authority of each said contracting officer; to provide for elimination of provisions relating to installation of equipment so that the same may be made the subject of a collateral contract; and further to provide that no claim for increase of the fixed-fees will be made by the contractor because of errors or omissions made in computing the original estimates or because the estimated costs vary from the actual costs, and the contractor has agreed to such modification upon the terms, conditions, and provisions hereinafter set forth.

Supplement No. 2 to Original Contract

This supplement, dated December 15, 1942, to the original contract was to modify the contract as so supplemented so as to include therein certain stipulations regarding payment of telegraph charges, subrogation, renegotiation, the Walsh-Healey Public Contracts claim, and statutory Provisions.

Change Order "A" to Original Contract

This change order to the original contract was dated July 17, 1942. The original contract did not comtemplate any construction work on the part of Hercules Powder Company. This change order provided that Hercules Powder Company perform or subcontract for the performance of certain additional construction, the additional construction to consist of the procurement and installation of one water tube boiler, its accessories, and the necessary connections to heat buildings of the plant.

Change Order No. 4 to Original Contract

This change order, dated April 24, 1943, to the original contract was a formal confirmation of instructions given to Hercules Powder Company by

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Lieutenant Colonel Fred H. Gallup in a letter dated January 8, 1943, to do all things necessary toward preparing to construct a building for crating purposes, and later to construct such along with the necessary facilities and appurtenances for the crating of bundled ammunition.

Supplement No. 5 to Original Contract

This supplement, dated May 19, 1943, to the original contract provided for a change in the Termination Clause.

Supplement No. 6 to Original Contract

In accordance with the provisions of the original contract, the Government, by a notice in writing, dated May 20, 1943, notified Hercules Powder Company to terminate operations at the New River Ordnance Plant and to place the plant in standby condition. The Government and Hercules Powder Company, after negotiations, arrived on August 1, 1943, at an agreement as to the estimated cost of the work to be performed by reason of such termination, and the amount of the fixed-fee to be paid for such termination. This supplement, dated January 25, 1944, to the original contract was a formal confirmation of the agreement arrived at on August 1, 1943.

12. Contracts for Construction, Mason & Hanger Company

A contract for constructing the plant by the Mason & Hanger Company, New York, was entered into between that company and the U. S. Government and signed on December 17, 1940. The contract was designated No. W-6451-QM-1.

The contract specified that the contractor should, in the shortest possible time, furnish the labor, materials, tools, machinery, equipment, facilities, supplies not furnished by the Government, and services; and do all things necessary for the construction of a plant to be located on a site to be furnished by the Government near Pulaski, Virginia, for the loading of propellant charges, including the igniter charges, and for the manufacture

of bags for such charges; the plant was to have an estimated daily capacity as outlined.

The constructing contractor sub-let part of the work toward the construction of the plant under the following subcontracts:

Subcontract No. 1, between Mason & Hanger Company and Pendleton Construction Corporation, Wytheville, Virginia, was to furnish 200,000 tons of crushed stone for roads, produced in a quarry on the plant site.

Subcontract No. 2, between Mason & Hanger Company and Virginia Machinery & Well Company, Richmond, Virginia, was to furnish plant supervision, insurance, labor, and material for drilling, casing, and testing an eight-inch-in-diameter well at a location on the site of the New River Ordnance Plant. This contract was later modified to include the drilling of a second and third well under the terms agreed to in the amendments, which were similar to the original contract.

Subcontract No. 3, between Mason & Hanger Company and The Chicago Bridge & Iron Company, was for the designing, detailing, furnishing, shipping, and erecting two 150,000-gallon elevated steel water tanks.

Subcontract No. 4, between Mason & Hanger Company and the Westbrook Elevator Manufacturing Company, New York, was for the designing, detailing, furnishing, shipping, and installing eight plunger-type elevators.

Subcontract No. 5, between Mason & Hanger Company and Guy M. Beaty, New York, was for the furnishing and installing insulation on pipes, fittings, and flat surfaces. This work pertained particularly to the pipes of the heating system in the buildings of the plant.

Subcontract No. 6, between Mason & Hanger Company and the Cement Gun Company, was to design and to furnish engineering services and labor for the construction of two 500,000-gallon gunite tanks for storing of water for the

plant.

Subcontract No. 7, between Mason & Hanger Company and the Automatic Sprinkler Corporation of America, New York, was for the purpose of furnishing the plant supervision, insurance, labor, and materials for sprinkler installation in eight Bag Loading buildings.

Subcontract No. 8, between Mason & Hanger Company and Crawford & Slaten Company, Charlotte, North Carolina, was for the purpose of furnishing the plant supervision, insurance; labor, and materials for sprinkler installation in 3 Igniter Houses, Laboratory, 3 Inert Warehouses, and the Hospital.

Subcontract No. 9, between Mason & Hanger Company and Century Sprinkler Corporation, Richmond, Virginia, was for the purpose of furnishing the plant supervision, insurance, labor, and materials for sprinkler installation in the Bag Manufacturing Building.

13. Acquisition of Land

The initial plan of purchasing, begun on the tract which was later found to be too small, was the employment of local agents acting under a local committee. The defects of this plan were: slowness of operation, alleged inequities in appraisals, controversies over appraisals, and failures to acquire property releases. A less personal approach was indicated. The Land Acquisition Division of the U. S. Department of Agriculture, under the supervision of Mr. James M. Gray, took over the responsibility of acquiring the land. Mr. Frank E. Fitzpatrick was directly in charge of the acquisition. The property was secured through a combination of voluntary agreements and proceedings of condemnation and court action.

Aside from the reluctance of the owners to part with their homes and farms, which had in some cases been possessed by the same family for generations, the difficulties of purchase were mainly imperfect or clouded

titles, incompetence of property holders to pass titles for other reasons, and other legal obstacles. There were 45 tracts of which 24 were acquired by condemnation.

The tracts acquired through condemnation were as follows:

Tract No. 1	Mrs. Annie C. Alexander
3	Eliza Conner Estate
8	Mary W. Patterson
11	Mrs. Annie C. Alexander
12	Annie P. Withrow
15	Agnes M. Altizer
16	L. M. Crabtree
17	Claude Trail
18	Walden Dudley Estate
25c	John L. Thompson and Estate of Elenor A. Sayers
26	W. W. Dudley
27	W. W. Dudley
28	Kent Farmer
30	Mrs. J. B. Farmer
34	Harry Landrus
37	John A. Mantz
42	A. L. Altizer
48	Mrs. Blanche M. Bocock
69c	W. H. McLeod & Walden Dudley Estates
72c	Annie Withrow
73c	Annie Withrow
74c	H. H. Farmer and Estate of Sallie D. Landrum
76c	H. B. Tabor and Estate of Sallie L. Watkins
80c	S. E. Hardwick and Estate of Sebastian Wygal

Of the 3,865.3 acres of the plant site, 3,834 acres were purchased by the Government and 31.3 acres were leased as follows: water line easement, 7.45 acres; sewer line easement, 9.26 acres; river service road, 3.93 acres; and lake front, 10.66 acres.

The acquiring of the land for the plant site was begun on November 4, 1940, with the first piece of property being purchased from Mr. H. S. Ward.

On April 22, 1942, the Commonwealth of Virginia ceded exclusive jurisdiction of the site of the New River Ordnance Plant to the Federal Government.

D. SAFETY DEPARTMENT (UNIT OF EXPLOSIVES DEPARTMENT)

All safety matters pertaining to the operation of Explosive plants were regulated by the manager of safety, who was directly responsible to the director of operations. The scope of his duties included the prevention of injuries to personnel and the prevention of property and material losses. Because of the characteristics of the process material, the manager's efforts were directed toward the prevention of explosions and fires and toward the arrangement of all operations, so that injury to personnel and damage to property would be limited if an explosion or fire occurred.

In order to insure the continued operation of plants, the company established a definite policy with reference to the safety of personnel and equipment. It was the object to provide all necessary facilities in order to eliminate as far as possible the danger from fire or explosion. The plants thus built were manned with operators who were thoroughly trained to operate the equipment, and who knew how to handle themselves whenever emergencies arose.

While the training of personnel was a necessary function of the local management, the manager of safety entered this picture as a source of information and educational material. An employee's Safety Handbook was made available. This booklet contained not only the general rules that applied to all workers but also the specific rules to be followed on each type of job. By keeping in touch with other organizations, such as the National Safety Council and the American Standards Association, the manager of safety brought together the best experience of others and saw that the necessary information reached those parties who could apply it in the interests of safety of operation.

To carry the company policy forward, it was necessary to provide adequate organization both at the Home Office and at the several plants. The organization was developed to carry on properly the different phases of the work, from design through engineering and construction to the continued performance after the plant was put in operation. During the first phase, the importance of safety in design and construction was under the direction of the safety engineer of the Engineering Department. The latter phase, including the development of new safety equipment, new methods of operation, and the training of operating personnel, was under the direction of the manager of safety of the Operating Department. In general, the policy pertaining to safety matters was determined and established by the Home Office Organization. On the operating plant, the safety policies were carried out in all Operations by the Operating Department, with the assistance of the Plant Safety Department. In general, the Plant Safety Department consisted of a safety superintendent, assistant safety superintendent, fire chief, shift safety engineers, and shift safety inspectors. The Plant Fire Department acted as a unit under the direction of the fire chief, who was responsible to the safety superintendent.

The requirements of facilities expanded to meet the increased demands of war production imposed a large burden on the management to insure safety of operation. The new plant might have been designed to produce new types or standard types of material. In either case, there was the tremendous problem of training new workers to handle safely hazardous material. In the latter case, there was the added burden of producing equipment that could process the new material in a safe manner.

All explosives processing equipment had to be designed to operate so that the chances for causing a fire or explosion were minimized; therefore, all

new designs and changes to existing designs were reviewed by the manager of safety to be certain that they complied with accepted standards. The standards were developed from experience and from careful testing and study of new materials and methods. The facilities of the Experiment Station, Engineering Department, and other departments were available to help in this work.

Through plant inspections and correspondence, the Office of the Manager of Safety provided a central control for the exchange of information and the coordination of safety work at the several plants. It was also the responsibility of this office to see that the plant was equipped with a Safety Department and a Fire Department, adequately staffed and supplied with facilities to suit their needs.

Valuable information was obtained from the reports submitted from the safety superintendents of the various plants. These reports showed the nature of things that cause injury to personnel and equipment. From the information in these reports, suggestions for improvements on both equipment and methods of operation were derived, so that accidents would not be repeated. Meetings were held of all plant safety superintendents, and from the free exchange of ideas, valuable information looking toward improvements was obtained.

The safety experience of the company was recorded in a systematic manner by the use of several forms. The Works Accident and Fire Report Forms were used to describe incidents involving property damage. Industrial Injury Forms were used to record the information pertaining to injuries to personnel. By summarizing the information conveyed by these reports, the manager of safety could appraise the effectiveness of the Safety Program, and therefore he could see where to devote his time and effort to improve

conditions.

The arrangement of the New River Ordnance Plant conformed to the pattern of High Explosives plants and was based on three fundamental conceptions: that the causes of explosions and fires be eliminated to the greatest possible extent; that the effect of an explosion or fire be confined to the building where it occurred; and that no steps be overlooked in protecting the personnel from injuries. The spacing of buildings in accordance with the Table of Intraplant Distances was a typical application of this policy.

An example of how safety was built into the process equipment could be found in the tubes used to deliver black powder to the charging machines. These tubes were originally built from light-gauge, seamless copper tubing. Tests demonstrated that such tubes offered sufficient confinement to cause the black powder to burn with explosive force when the powder was ignited with a flame. Ignition during operation would blow the tubes to bits and would probably severely injure any exposed personnel. Further tests with slit tubes demonstrated that under similar conditions such tubes would simply open up and remain in one piece. With this arrangement, there was practically no confinement and the powder burned without explosive violence. Since shielding was impractical, the use of slit tubes was adopted as a reasonable way to reduce the danger to the operating personnel.

Operating equipment was continually studied to take advantage of improved methods. This study might have taken place by installing a model of the unit at a safe, remote location where the effect of a fire involving operating quantities of material could be observed safely. A test on the mock-up of a sealing machine led to the recommendation that additional shields be provided around the charging door. The value of the additional protection provided by the shielding of the machines as suggested was brought out when,

at a later date, an accidental fire was confined to the room in which the machine was located and did not communicate to the operator's working position.

F. ADDITIONAL PLANT FACILITIES

Rehabilitation of Bag Loading Lines 1, 2, 3, and 4 required no new design work. Except for the conservation of critical materials, the buildings for the Bag Loading Line No. 5 were of similar construction to those on Bag Loading Lines 1 to 4 inclusive.

The Flash Reducer Loading buildings were designed to house six volumetric charging machines in each building. These machines, designed to perform a loading operation which had heretofore been done manually, brought a 200% saving in manpower and increased operating efficiency and accuracy.

The buildings were constructed with concrete foundations and 5" concrete floors, which were covered with 1/4" Hubbellite. The operating bays were enclosed on three sides by 12" concrete fire walls. The exterior wall of each bay was of a light-frame construction lined with 1/4" H. E. Finish Transite, which was nailed with brass or copper nails. This wall was lightly attached to the building proper and served as a "blow-out" panel.

The roof also was of typical construction with 2"-x-6" rafters spaced 2'-0" on center, covered with Cellotex over which white, roll-top roofing was applied.

Buildings 1 and 8 were 9' longer than Buildings Nos. 2 to 7 inclusive, because of the addition of an Inspection Room. Construction of other buildings required for the Flash Reducer Loading Line was in general typical, requiring no additional important design work.

A total of 290 drawings was used for the various plant additions which were constructed in the period September 1, 1944, to August 13, 1945. Of these 185 were new drawings; 101 were re-approved drawings; and 4 were void drawings.

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A breakdown of drawings required by the project and a summary for all projects follows:

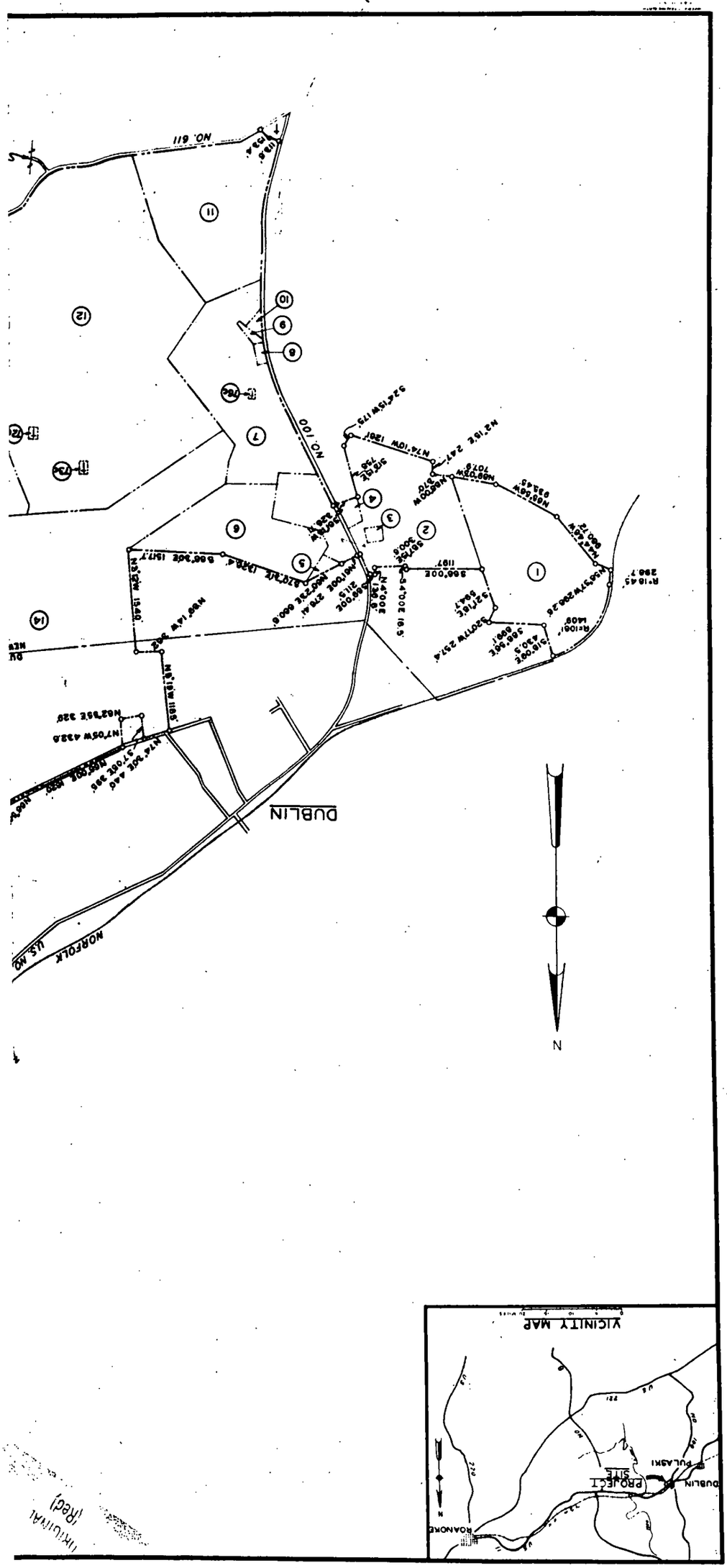
Increment Cellophane Wrapping Plant	
Approved New Drawings	54
Re-approved Drawings	14
Void Drawings	--
Total	68

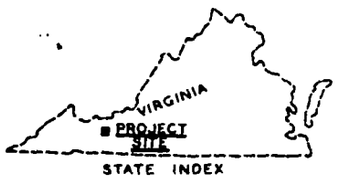
Rehabilitation of Bag Loading Facilities Lines 1, 2, and 3	
Approved New Drawings	35
Re-approved Drawings	3
Void Drawings	1
Total	39

Flash Reducer Loading Lines	
Approved New Drawings	54
Re-approved Drawings	--
Void Drawings	--
Total	54

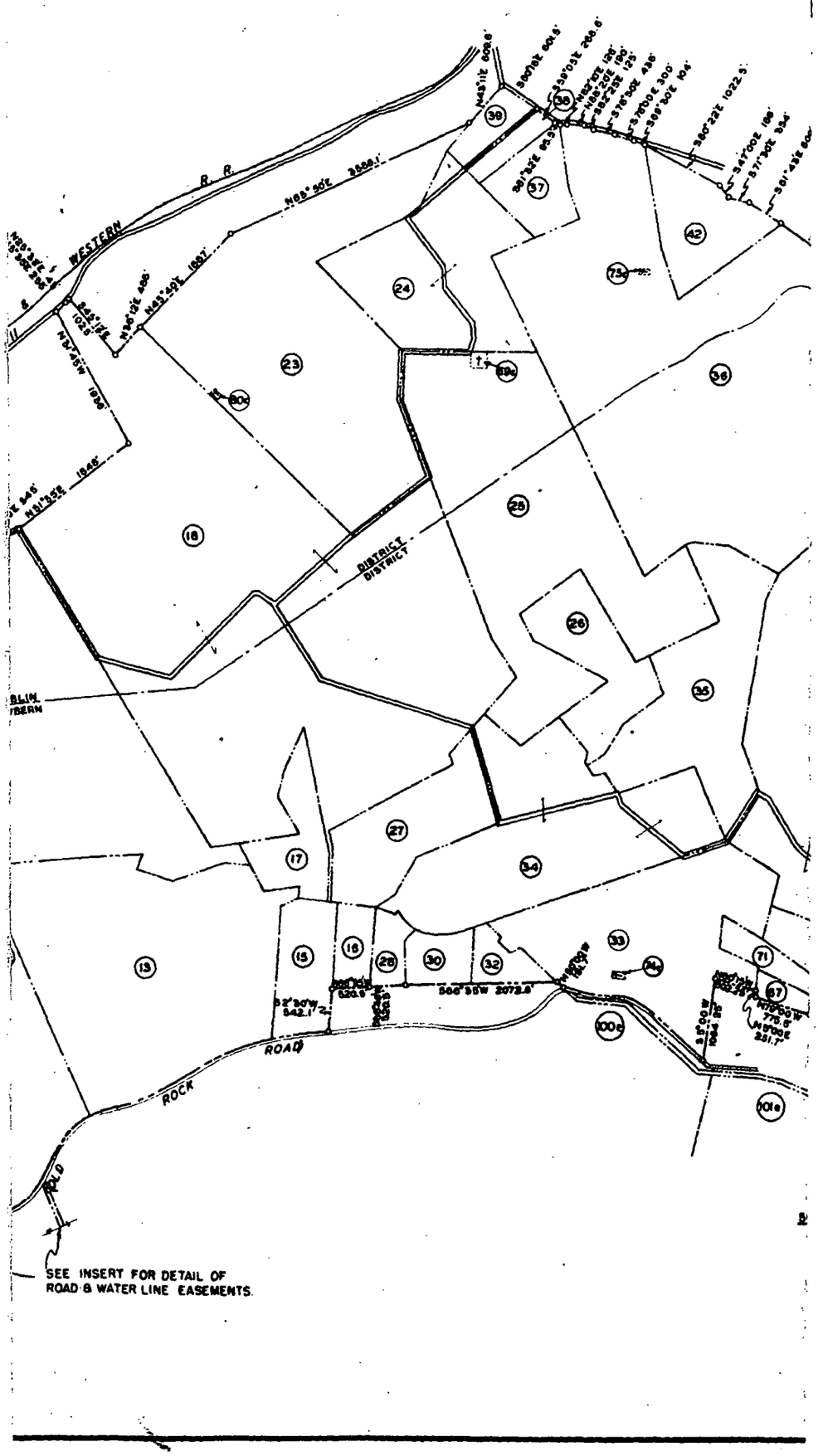
Bag Loading Lines No. 4 and No. 5	
Approved New Drawings	42
Re-approved Drawings	84
Void Drawings	3
Total	129

NOTE: All drawings required for this project had been completed before construction was stopped.



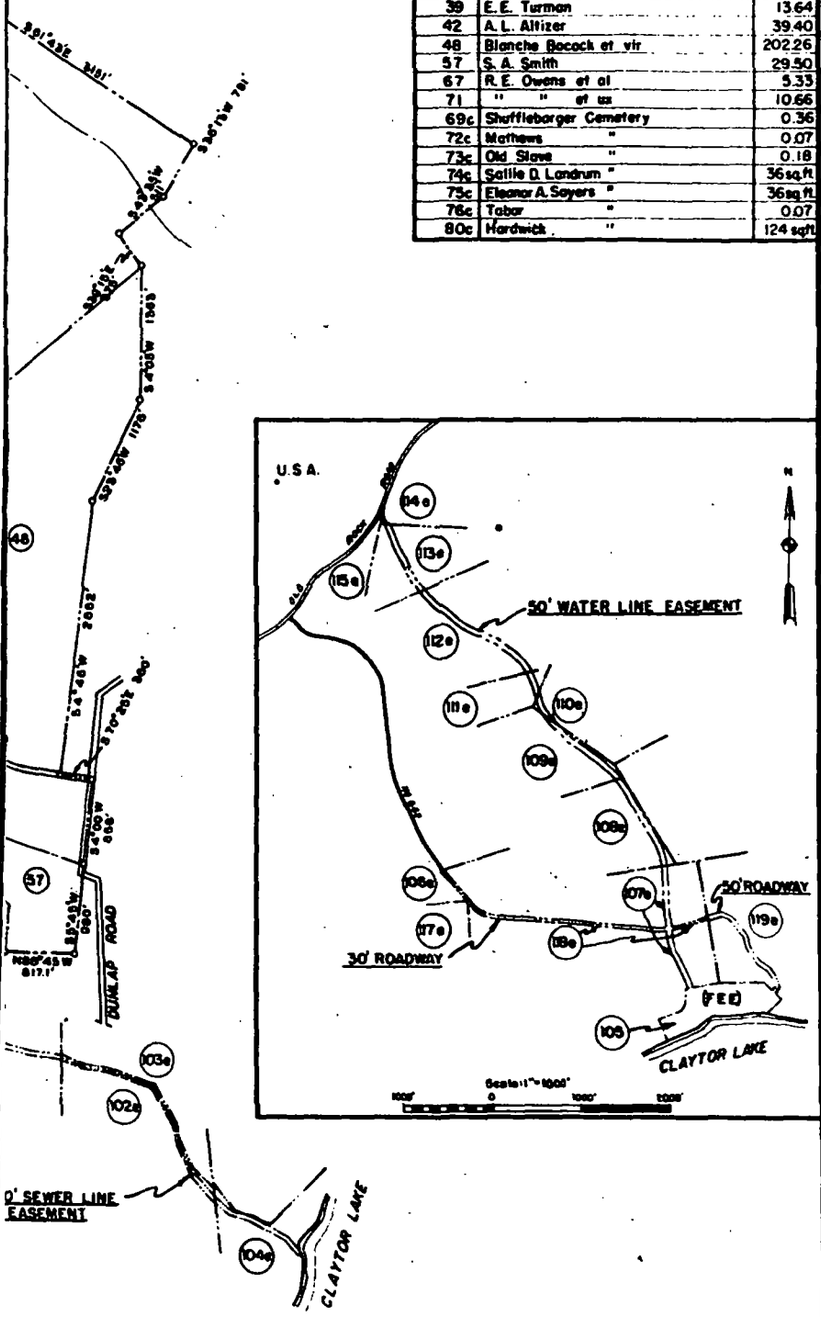


ORIGINAL (Red)



TRACT NO.	VENDOR	ACRES
100e	C. W. Morehead	2.58
101e	Lucy H. Copenhaver et vir	2.36
102e	E. M. King et ux	1.72
103e	R. L. King et ux	1.22
104e	L. J. Covey et ux	1.33
105	Appalachian Elec. Power Co (FEE)	10.25
106e	Annie P. Withrow Est.	0.51
107e	Mary L. Morris Est.	1.49
108e	Sarah E. Graham et vir	1.12
109e	J. D. Thornton et ux	1.26
110e	Lucy A. Vaughn	0.17
111e	Ella R. Jennings et vir	0.35
112e	L. J. Covey et ux	1.76
113e	Stella Linkous Est.	0.70
114e	E. J. Smith et ux	0.08
115e	D. E. Linkous	0.04
117e	Wm. A. Lyons	0.01
118e	Mary L. Morris Est.	1.62
119e	E. P. Lyons	1.47

TRACT NO.	VENDOR	ACRES
	FEE	
1	Mrs. Annie C. Alexander	83.14
2	Mrs. E. B. Mebane et vir	81.95
3	Eliza Connor Est.	1.18
4	Marion Epperly et ux	2.09
5	Helen S. Trinkle et al	1.86
6	F. H. Jordan et ux	52.33
7	H. T. Tabor et ux	74.97
8	Mary Patterson	1.14
9	Wm. Page	0.96
10	N. B. Anderson	1.00
11	Mrs. Annie C. Alexander	86.00
12	E. W. Bell et al	368.30
13	H. E. Bocock	209.00
14	Helen S. Trinkle et al	374.20
15	Agnes M. Altizer	30.30
16	L. M. Crabtree	14.70
17	Agnes M. Altizer et al	29.00
18	W. W. Dudley Est.	563.65
23	S. E. Hardwick	229.67
24	R. K. Morgan et ux	100.00
25	Mrs. K. S. Mc Leod	228.56
26	W. W. Dudley	46.45
27	" "	53.00
28	Ken Farmer	10.60
30	Mrs. J. B. Farmer	14.75
32	Virgie S. Farmer et vir	11.80
33	H. H. Farmer et ux	119.56
34	Harry Landrum et al	144.30
35	R. E. Smith et al	95.20
36	J. L. Thompson	463.00
37	J. A. & L. E. Mantz	25.07
38	G. E. Marshall et al	7.68
39	E. E. Turman	13.64
42	A. L. Altizer	39.40
48	Blanche Bocock et vir	202.26
57	S. A. Smith	29.50
67	R. E. Owens et al	5.33
71	" " et ux	10.66
69c	Shufflebarger Cemetery	0.36
72c	Mathews "	0.07
73c	Old Slave "	0.18
74c	Sallie D. Landrum "	36 sq. ft.
75c	Eleanor A. Sayers "	36 sq. ft.
76c	Tabor "	0.07
80c	Hardwick "	124 sq. ft.



FINAL PROJECT OWNERSHIP

TYPE OF MAP

VIRGINIA (Reg)

STATE · VIRGINIA
COUNTY PULASKI
DIVISION MIDDLE ATLANTIC
DISTRICT NORFOLK
SERVICE COMMAND THIRD
USING AGENCY ORDNANCE DEPT.
40 MILES SW OF ROANOKE
MILES OF

TRANSPORTATION FACILITIES

N & W	RAILROAD
NO. 100	STATE ROAD
NO. 11	FEDERAL ROAD
NONE	AIRLINE

LAND AREA

ACRES OWNED BY W.D.	3837.13 +
ACRES LEASED BY W.D.	NONE
ACRES LEASED FROM W.D.	NONE
ACRES TRANSFERRED TO W.D.	NONE
ACRES DONATED TO W.D.	NONE
ACRES EASEMENT	19.79

DISPOSALS

ACRES SOLD	NONE
ACRES TRANSFERRED	NONE
ACRES EXCHANGED	NONE
ACRES OTHERWISE	NONE

LEGEND

- RESERVATION LINE
- STATE OR PROVINCE LINE
- COUNTY LINE
- CIVIL DISTRICT PRECINCT
- LAND-GRANT LINE
- CITY, VILLAGE, OR BOROUGH
- CEMETERY, SMALL PARK, ETC.
- TOWNSHIP LINE
- SECTION LINE

Scale
1" = 1000'
1000' 0 1000' 2000'

WAR DEPARTMENT, O.C.E.
CONSTRUCTION DIVISION

REAL ESTATE

NEW RIVER ORDNANCE PLANT

MILITARY RESERVATION

RECOMMENDED: [signature] ASSOC ENGINEER DATE 10 Aug 43

APPROVED: [signature] MAJOR, CORPS OF ENGINEERS DATE

COMPILED: TRACED: C.H.L-H CHECKED: B.A.P.

DATE	BY	REVISIONS	APPROVED

SHEETS: OF DRAWING NO. MAD 18

CR-Form-177A

PART II — THE PLANT

SECTION I

Design, Supervision of Construction, and Construction Contractor

67

Chapter IV

MANAGER'S RESPONSIBILITIES - CONSTRUCTION

A. Introduction

1. Responsibilities, Projected Organization

The manager of the plant was given the duty of carrying out the contractual obligations of Hercules Powder Company in connection with this establishment. Briefly, they were to design the plant, perform the architectural and engineering service, technically supervise the construction of the project, procure and install operating equipment, train operating personnel, and operate the plant. These functions have been mentioned in Chapter II, paragraphs 6 and 10.

It will be noted that the contract stipulated that Hercules would furnish architectural service. This particular requirement obligated Hercules to assist the Government in determining that the construction contractor (a collateral contract) build the plant in accordance with the plans, drawings, and specifications as approved by the Government.

It will also be noted that the contract stipulated that Hercules would "Technically supervise the construction of the project." This clause was interpreted to mean that Hercules, in addition to being responsible for preparing the lay-out plans, drawings, and specifications for approval of the Government, was responsible for supervising construction so far as technical operating matters might be concerned, thus assuring that the plant, when completed, would accomplish the object for which built.

The Government contracting officers' representatives on the site of

the project, through their War Department inspectors and the assistance of Hercules representatives on technical matters during construction, were responsible for seeing that all matters were carried out in accordance with the contract. All work, when completed, was inspected by representatives of Mason and Hanger, the Ordnance Department, the Quartermaster Corps, and Hercules Powder Company. Representatives of Ordnance and Hercules accepted it.

The first problem to be given consideration was to study the requirements of the contract and then form an organization appropriate for the task.

After an inspection of the Government Loading plants and a study of the design and engineering aspects, together with the operating requirements, the work was divided into the following five main groups:

a. Plant, building, and equipment design

b. Field engineering

c. Hiring and training key personnel

d. Planning and scheduling production, and estimating material and personnel requirements.

e. Purchasing

Group (a) was in the hands of Mr. Johnson Roney, II, as chief draftsman and Mr. Robert Cotter as assistant chief draftsman. Upon completion of the design work at Wilmington, Mr. Roney was made assistant chief supervising engineer, and Mr. Cotter was continued as chief draftsman at the plant. All designs and drawings were scrutinized and approved, in person or in delegation, by the plant manager.

Group (b) was in charge of Mr. Ernest D. Bean as chief supervising engineer of construction. His was the responsibility for surveys, locations, grades, inspection, progress reports, and general execution of the construction supervision.

Group (c) was delegated to Mr. George R. Foulke, Jr., as assistant manager and to Mr. Lewis C. Kleinhans, general superintendent.

The plant manager undertook Group (d) with the assistance of Mr. C. T. Butler who was slated to be assistant manager in charge of production; however he was assigned to other duties as soon as these studies were completed, and the manager carried this group until the organization began to function at the plant, at which time the schedules were assigned to Mr. Foulke for execution under his function as assistant manager.

Group (e) was handled by Mr. M. P. Sarfarty, first at Wilmington, then at New River. This included the writing of purchasing specifications, and covered all the operating equipment and materials purchased directly by Hercules Powder Company.

B. Engineering and Design

1. Design Preliminaries

The contract called for a plant having an estimated daily capacity, based on working twenty-four hours per day, as follows:

No. of Lines	Type Charge Loaded	No. Charges Produced in 24 Hrs.	Pdr. Loaded in 24 Hours
2	105 MM. How.	16,000	46,000
1	155 MM. How., M2	8,000	66,000
1	155 MM. Gun, M1918	4,000	100,000
		28,000	212,000

2 Igniter Charge lines.

The preceding-rated capacities were based on three eight-hour shifts per twenty-four hours.

The plant was to consist of 4 Propellant Charge Bag Loading lines, 2 Igniter Charge Bag Loading lines, and appropriate hoppers; Bag Manufacturing buildings, Administration buildings, Shops, railroads, roads, steam lines, air lines, electric lines, telephone lines, fencing, lighting, Power House, Dormitories, water system, Staff Dwellings, Cafeterias, Guard Quarters, fire-fighting equipment and housing thereof; and other buildings and equipment necessary or appropriate for a Bag Loading Plant of the approximate capacity aforesaid, with Storage buildings adequate for about 30 days' supply of incoming material and about 60 days' production of finished product. Every Propellant Charge Bag Loading Line above referred to was to be capable of loading any type of charge except stacked charges at rates shown on Drawing No. SK-7982, dated October 28, 1940, on file in the Office of the Chief of Ordnance, and equipment was to be provided so that one of said lines could be adapted to load stacked charges.

This contracted estimated daily capacity was a reduction from that used in the early estimates for preparing the contract. The reduction caused a corresponding decrease in the whole plant design as envisioned, and the altered character of types of charges to be loaded necessitated a revision in the scheduled personnel.

The broad requirements of the contract had to be analyzed and broken down into types and quantities of operating equipment and other elements or factors making up the plant as a whole before the engineering and design work could be started.

Basic elements to be considered were the following:

Bag manufacture (including bags for igniters)
Bag loading (including igniters)
Charge assembling, packing, and shipping
Black-powder screening and drying
Transportation of materials, external and internal
Warehousing of inert (non-explosive) materials
Magazines for explosives, incoming and outgoing
Guarding
Fire protection
Safety
Water supply
Sewage treatment
Electric power and light
Heating
Roads
Railroads
Fencing
Housing
Medical and hospital requirements
Personnel transportation (internal and external)
Commissary
Recreation
Maintenance
Accounting
Administration
Preliminary training of operators and supervisors

Many controlling decisions, such as number and size of Warehouses; kind, number, and size of Magazines; hospital facilities required; safety distances, etc., had to be made in collaboration with the Ordnance Department. Approval of all drawings by the Loading Section of the Ordnance Department in Washington was required.

Thirteen Warehouses (48' by 208') were eventually authorized for inert materials, and since these had to be served by railroad, and had to be in a group separated by safety distances from all Explosive Operations, the general location of their site was logically fixed at some spot near the railroad entrance, where a sufficient extent of fairly level terrain would avoid excessive excavation and fill. This location had to be chosen with

respect to the ruling grade and curvature permitted by the Norfolk & Western Railroad for the interior tracks (2% for grade and 8° - 11° for curvature) and also by the fact that the railway had to cross over highway Route 100 with an established minimum clearance of fourteen feet.

The railway limitation also had to be considered in the layout of the sorting yard west of Route 100, which during construction was to be used as a contractor's focal point for building materials and for a concrete mixing plant, as well as an employment center; and during operation of the plant, as a classification yard for incoming and outgoing freight for the purpose of separating the inert from the explosive shipments and for making up the outgoing trains of mixed shipments.

The above details are cited to show only one example of the interlocking character of the design problems. These complex problems necessitated a considerable amount of preliminary work in the office and in the field before practicable designs could be made.

Studies were made (revised for alterations in War Department directives as to schedules, etc.) to determine the size of operating rooms, their most economical relative positions, the spacing of buildings in each line, the most efficient combination and sequence of operating steps, the characteristics and number of personnel, etc.

2. Organizing for the Work

Initial studies, typical layouts, and a preliminary estimate had been prepared by the Home Office Organization of the Hercules Engineering Department. It soon developed, however, that because of other demands very little more could be counted upon from that source, and that a new

Engineering and Design Organization must be established, devoted solely to this New River job.

The initial organization was as illustrated by the Organization Chart shown below.

The preliminary estimate of the key personnel required was as follows:

	Estimated Monthly Pay Roll	
	Initial	Ultimate
Manager	1	1
1st. Asst. Manager (Materials - Purchasing, Storing, Shipping, Production, Maintenance, Repairs, and Plant Personnel)		1
2nd. Asst. Manager (Services - Hospital, Safety, Guards, Firemen, Sanitation, Sewage, Food, and Office Personnel)		1
Chief Construction Engineer	1	
Project Engineer	1	
4 Assistants	4	
Plant Engineer (Maintenance, Power, Repairs, etc.)		1
Maintenance Engineer (Asst. Plant Engineer)		1
Superintendent of yards, roads, and tracks		1
Production Superintendent		1
Asst. Production Superintendent		1
Chief Chemist		1
Chemist		1
4 Loading Line Supervisors		4
2 Black Powder Supervisors		2
1 Bag House Superintendent		1
3 Asst. House Superintendents		3
Service Superintendent		1
Safety Engineer	1	1
Superintendent of Sanitation		1
Chief Guard	1	1
Fire Chief	1	1
Office Manager		1
Asst. Office Manager (Chief Clerk)	1	1
Traffic Manager	1	1
Asst. Traffic Manager		1
Purchasing Manager	1	1
Asst. Purchasing Manager		1
Personnel Manager (Plant)	1	1
Plant Doctor (part time)		1
Resident Interne (full time)	1	1

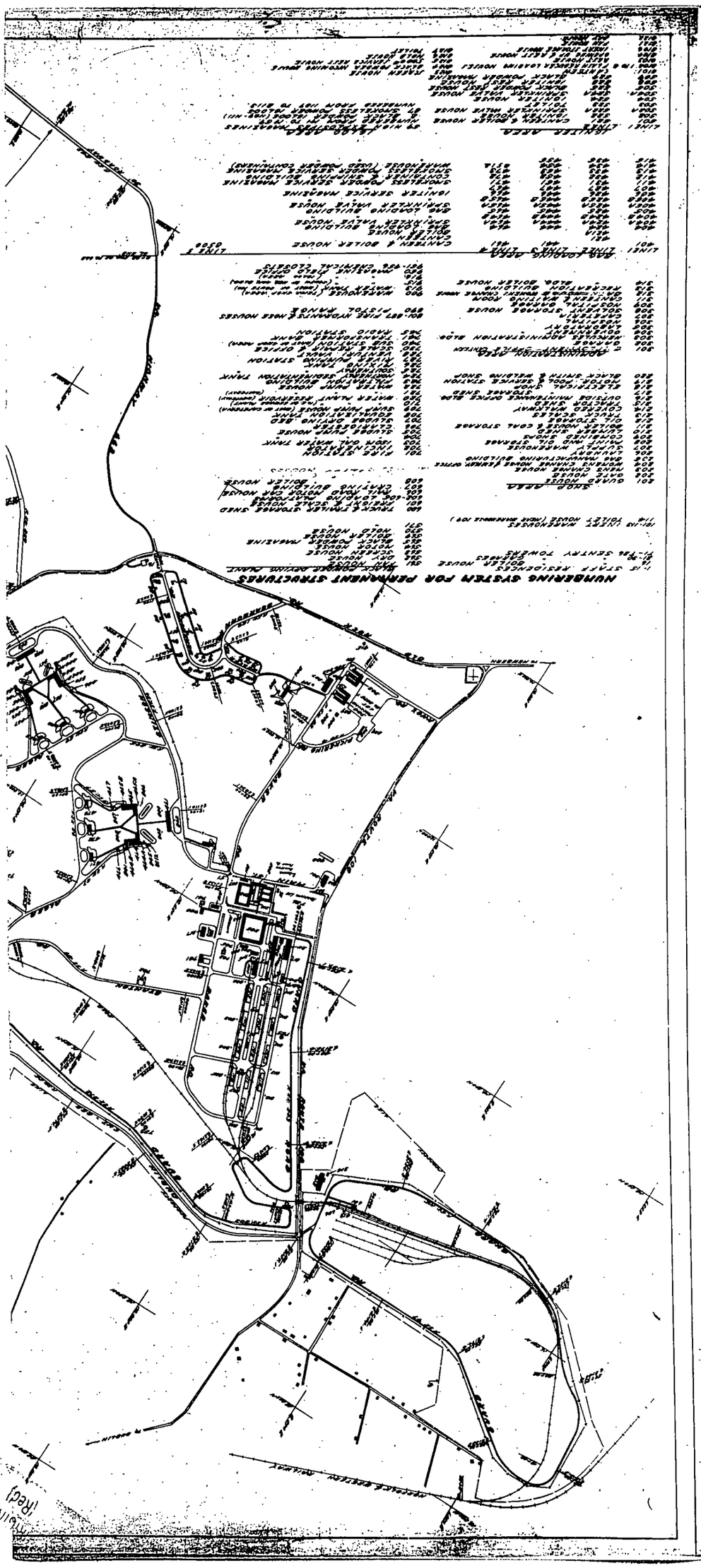
engineering talent was called for in the design, a fact which facilitated the organization required.

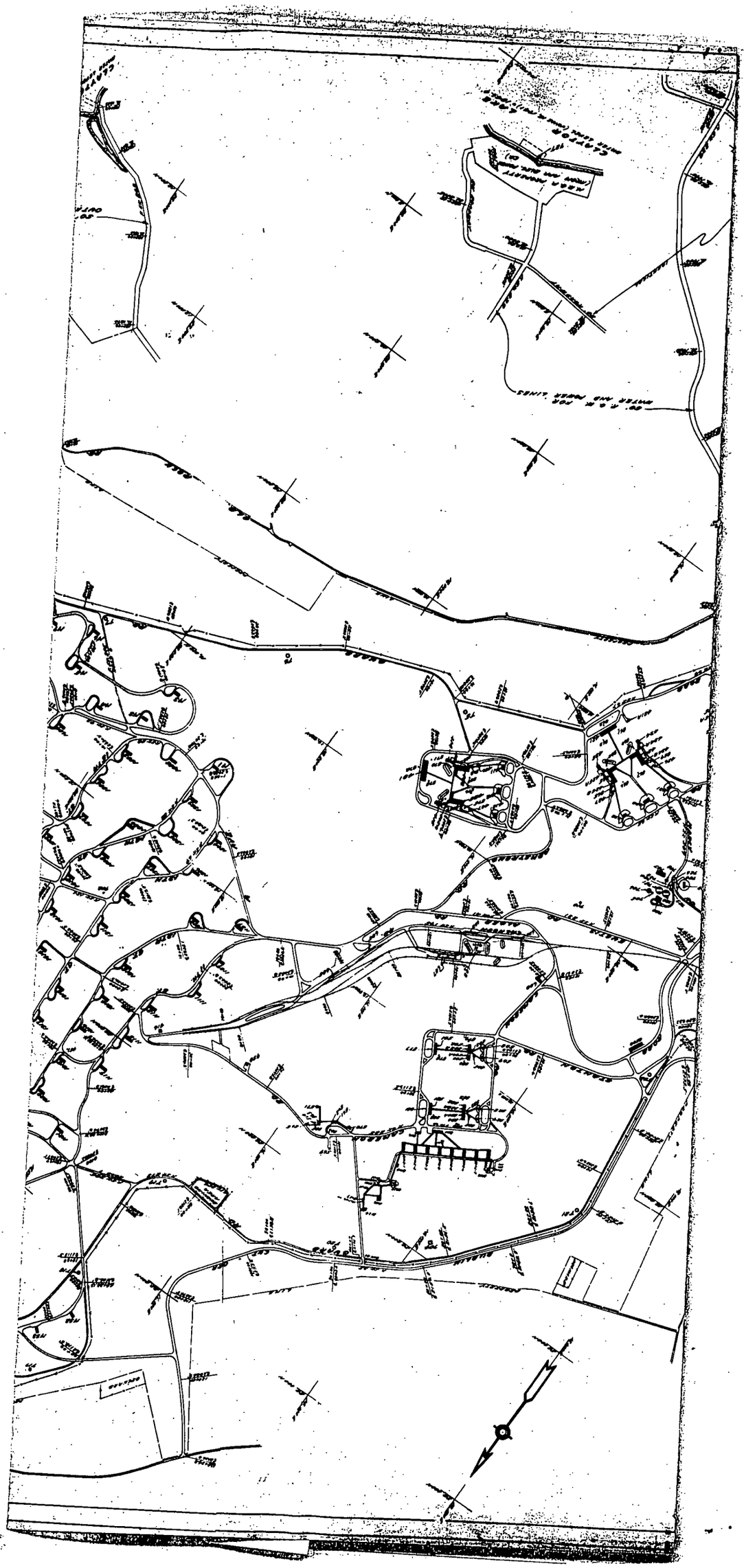
3. Survey of Site and Plant Layout Map

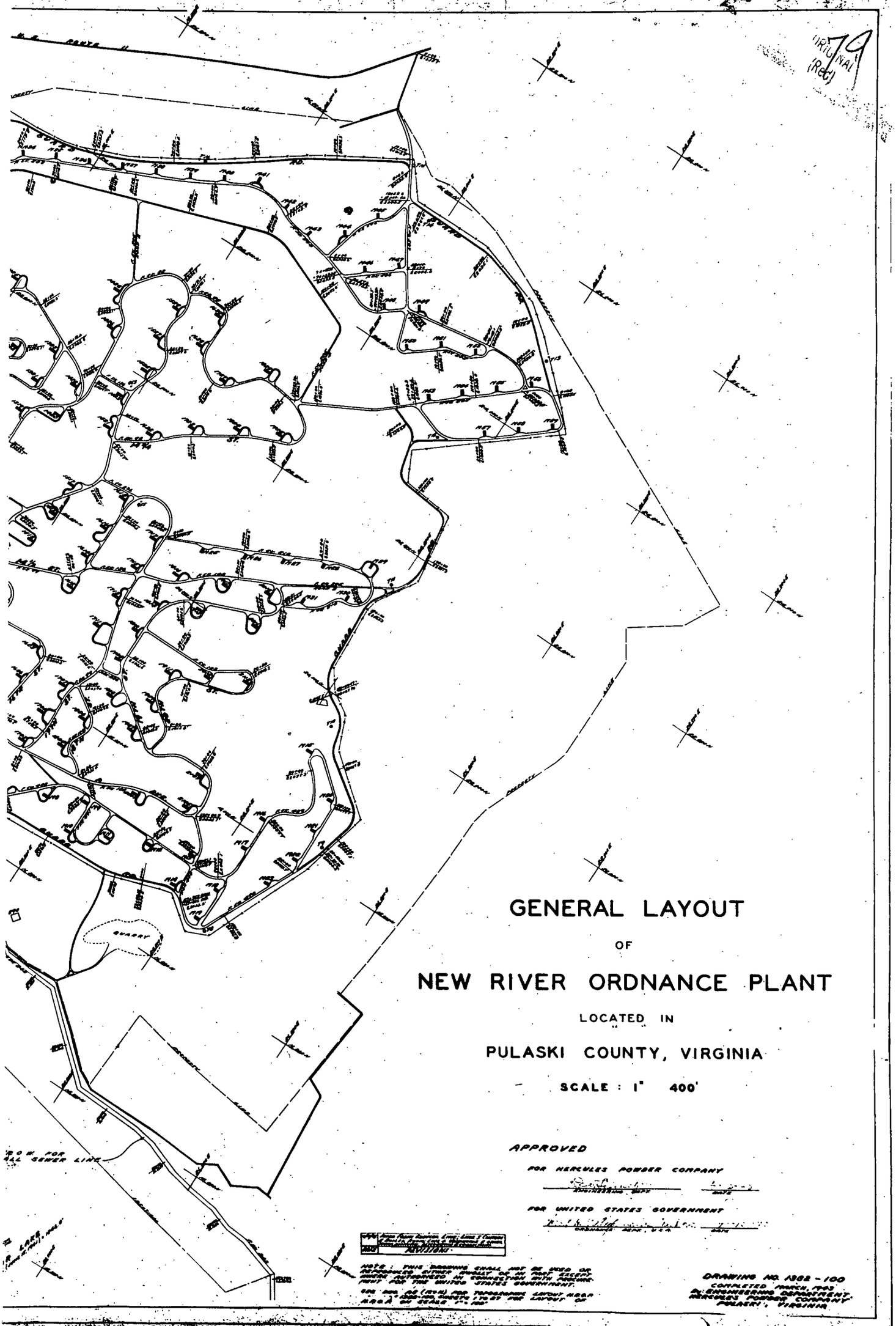
The first "surveying" on the site was done with hand levels, steel tapes, and level-rods by a group of engineers of the Norfolk & Western Railway, Mason & Hanger Company, and Hercules Powder Company on February 5, 1941, as a reconnaissance to establish a tentative route for a railway spur into the property. It speaks well for the judgment of these engineers that the route thus selected was very nearly the one finally established by subsequent transit surveys.

Previous to this, as soon as the site had been definitely selected, efforts had been made to initiate a topographical survey. Since surveying instruments were very scarce, a sufficient number could hardly be purchased. There was supposed to be a governmental supply available, but only a few leveling rods were procured from this source. It was evident that transits and levels were mostly in private hands. Surveyors of all grades of experience were likewise scarce, and it seemed best to sublet the topographical surveying if possible. Accordingly, several bids were taken, but these were not accepted for various secondary reasons, such as price and experience; but the chief reasons were the time estimated and the difficulties of harmonious co-functioning between such an organization and the field forces of Hercules Powder Company and of the construction contractor, Mason & Hanger Company.

This problem was happily solved by the offer of Mason & Hanger to start the topographical work with instruments belonging to them and with the







GENERAL LAYOUT

OF

NEW RIVER ORDNANCE PLANT

LOCATED IN

PULASKI COUNTY, VIRGINIA

SCALE : 1" 400'

APPROVED

FOR HERCULES POWDER COMPANY

_____ _____
ENGINEERING MGR. DATE

FOR UNITED STATES GOVERNMENT

_____ _____
CONTRACTING OFFICER, U.S.A. DATE

NOTE : THIS DRAWING SHALL NOT BE USED OR REPRODUCED EITHER WHOLLY OR IN PART EXCEPT UNDER AUTHORITY IN CONNECTION WITH CONTRACT WITH THE UNITED STATES GOVERNMENT.

DRAWING NO. 1382 - 100
COMPLETED MARCH, 1943
ENGINEERING DEPARTMENT
HERCULES POWDER COMPANY
PULASKI, VIRGINIA

surveyors already on their rolls. As the Hercules Company's field force was augmented and instruments acquired, these were applied to this job also. This cooperation was not only timely but most practical. The topography could be surveyed and mapped as required for planning and construction, instead of waiting for full completion, and thus the needs of progress were met to best advantage.

The over-all, original topographical maps for construction were prepared by Mason and Hanger.

Hercules' field engineers, under Mr. E. D. Bean, prepared the topographical maps as to detail areas pertaining to construction. Prints were sent to Wilmington, where layouts were made and returned to the field for justification.

The first layout concerned the railroad spur, as this involved the handling of construction materials, and hence safety distances were not in question; controlling grades and curvature were the criteria. A bridge to be built over highway Route 100 involved traffic clearance, and of course the balance of cut and fill with a minimum of excavation, especially rock, had to be considered. The railway location had to be coordinated with the facilities it was to serve; therefore, a measure of tentative layout was tied in with this feature.

The Service groups, that is, Warehouses, Administration buildings, Employment offices, Shops, Boiler House, etc., were next located. These involved no safety inter-distances. Considerations of transportation and communication chiefly prevailed.

Next came the Production units: the Loading lines, the Black Powder

lines, and accessory buildings. Safety distances and transportation requirements prevailed. Then the Igloos--the warehouses for explosives--were located. Safety distances and transportation were the criteria here.

The location of Loading lines and of Igloos was very difficult, especially the locating of Igloos, as a result of the safety restrictions and the terrain which is hilly. The location of Igloos became wholly a field engineering problem. The location of Loading lines was shifted somewhat as expensive rock excavation was encountered.

The location of the Water Plant and the Sewage Plant followed. A Staff Village was also the subject of much consideration before a layout satisfactory to all concerned, military and civilian, was concluded.

Temporary hospital facilities were, of course, provided, but the location of the permanent Hospital Building was the last one to be fixed.

4. Types of Construction Prescribed

The Government prescribed that wherever consonant with use, all buildings should be of the "three-year" type, and interpreted this as meaning wood-frame construction on wood mud-sills or posts, weather-board and batten siding, and in general a very temporary and flimsy construction. (A bit of incongruity was the requirement of termite-proofing!) Another phrase used in the instructions was "tropical construction." Some photographs of a three-foot snowfall of two winters previous exhibited to the Washington Office concerned put an end to the "tropical" theme. Eventually a sturdier type of construction was approved, ostensibly a "three-year" type, for such buildings as came in the Service groups. For safety reasons, all Explosives buildings (Lines and Igloos) were of

reinforced concrete.

All in all there were three changes in design plans: originally the plan was to follow the pattern of the buildings at Radford; later the "tropical" theme idea was introduced; and finally the design that was later actually used was effected.

Because of steel shortage, the Inert Materials Warehouses had wooden frames and rooftrusses, as did smaller buildings. As the result of the long spans required, the framing of the Bag Manufacturing Building trusses was of steel, the same being true of the large Change Houses.

5. Preparation of Designs

a. Design of Buildings and Auxiliary Facilities

(1) Administration Building

The Administration Building for housing the executive staffs of the War Department and Hercules Powder Company was the subject of much indecision. Several designs were made and, finally, a complete set of drawings, which were first approved but which were later rejected because the type was too permanent. Eventually permission was granted to duplicate the Mason & Hanger Administration Building with the exception of the addition of a concrete vault for records.

(2) Bag Manufacturing Buildings

It was necessary to study the existing operations of bag manufacture. These were at Picatinny Arsenal, New Jersey, for the Army and at Iona Island, New York, for the Navy. Inasmuch as all the scheduled loadings were for the Army, studies were confined to Picatinny Arsenal where all the operations of bag manufacture and loading were in process.

Bag loading on a smaller scale, with a different layout, was also done at Curtis Bay, Maryland, where operations were studied. Time and production studies were made; and unit quantities of materials, equipment, floor space, and personnel per unit of output were calculated for all the loadings scheduled.

Inasmuch as the operations at Picatinny Arsenal had gradually developed a little at a time, under peace-time conditions, the equipment and arrangement were naturally not in accordance with the greatest possible efficiency.

The Ordnance Department first insisted upon having two separate units for bag manufacturing. Hercules finally got what they wanted, namely, a Bag Manufacturing Building with one half of the building designed to contain sewing machines and the other half to contain facilities for Printing, Punching, and Cutting Operations.

By redesigning the layout and simplifying the relations between operations, straight-lining and shortening the travel of material, with some improvement in equipment, an improved design was evolved upon which an output per unit of equipment and personnel was predicted to be considerably in excess of the rated capacity of Picatinny's facilities. Of course, the unit cost would likewise be reduced. A quota was therefore set up for bag manufacture, 20% over that for Picatinny. Hercules actually averaged 5% to 10% above the quota set up, and their most experienced operators averaged 100% above it, or 240% of Picatinny's quota.

(3) Bag Loading Buildings

The foregoing remarks as to design study apply to bag loading

also. The larger quantities handled and improved means of transportation were conductive to predictable economics.

All of the equipment of the Bag Loading plants was designed by Hercules with exception of the equipment for loading stacked charges. The stacked-charge machine as finally used was developed by the Hoosier Ordnance Plant.

It is worthy of note that Hercules advised the Ordnance Department in conversations that they would exceed their scheduled capacity by at least 2 to 1 (estimated 3 to 1) and that their contemplated further construction of Bag Loading plants should be based upon such higher output capacities. Hercules was informed that their schedule would not be changed. There was established a record of 405% and 408% of scheduled loading rates on two different types of loadings, and of 308% on another. Records of 277%, 229%, and 215% were made on "stacked" charges, in which manual operations were predominant. See later under "Production."

Hercules wanted to effect two-way loading in individual operating rooms as shown in original drawings. This was denied by Ordnance in 1941 but was later authorized in 1944.

(4) Black Powder Screening and Drying, and Igniter Loading

This design was a combination of those in use at Picatinny Arsenal and at Curtis Bay.

(5) Warehouses for Inert Materials

The design of the thirteen large Warehouses, totaling 130,000 sq. ft. of floor surface, was governed by the predicted requirements for storage of silk cloth (afterward cotton cloth also), assembly pieces

(called "clover-leaves"), containers, thread, spare parts, etc.

As shortage of steel developed, it was necessary to change the roof truss design from steel to wood. Hercules was told that their design of warehouse has been copied for use in other Ordnance plants. Each Warehouse was 48 ft. wide by 208 ft. long.

Other storage was provided for lumber, paint and oils, fuel oil, gasoline, etc.

(6) Magazines for Explosives

The original requirement of 30 days' incoming and 60 days' outgoing explosives storage finally was resolved into 2 Black Powder Igloos and 87 Smokeless Powder Igloos. The design for these Igloos was furnished by the Ordnance Department. (The door to the Magazines was designed by Mr. Henry Marsh of Hercules Powder Company.) The design of the Igloos was later altered, by authorization, at the request of Mason & Hanger, to a more practicable design. Hercules tried to get the floor level of the Magazines raised to truck-bed height. Ordnance refused this request; later, though, this change was allowed in other Ordnance plants.

The Igloos were of a semi-cylindrical shape and of reinforced concrete covered with earth. Hercules did not approve of them, preferring their standard type of light, shatterable construction. The Ordnance Department insisted upon this design, because it was thought to be cheaper and because it had no barricades; and in case of explosion, the front end was expected to blow out in a straight line, while the rest of the Igloo remained intact, or at least no large missiles would fly a great distance. Recent experience with a TNT explosion has proved these tenents wrong.

The whole Igloo was disrupted and large portions flew great distances. These Igloos were spaced 400 ft. or more apart sidewise and 800 ft. or more along their longitudinal axis.

The Black Powder Igloos were approximately 26' by 40' inside. The others were 26' by 60' inside.

Later, in 1942-43, fifty-nine other Magazines were built to house explosives from Radford. These had concrete and brick walls and wooden truss roofs, and were earth-banked up the side walls. They were 26'-6" by 60'-8".

(7) Guard Facilities

This feature of the design did not require reference to existing military establishments, as Hercules already had a Plant Protection Division in the Explosives Department. This division functioned as a consultant in the design, and covered not only the Guard Forces but the items of guard fencing, lighting, sentry boxes and towers, guards' equipment (arms and uniforms), and guards' headquarters. The Guard Headquarters was placed close to the main (and only) gates into the "Guarded Area." The whole site was guarded, but "Guarded Area" here means the area within the six-ft. chain-link fence, enclosing that portion of the plant where explosives were handled and stored. It included the railroad yards west of Route 100.

Fence lighting was accomplished by using three 2300-volt series circuits around the Guard Fence, with the constant-current transformers being located in the Electric Substation. Novalux Liminary fixtures were placed at approximately 150-foot intervals inside the fence.

Guard Headquarters was designed for a force of approximately 270 guards. This number was later exceeded, a maximum of 343 guards being employed in May, 1942. A Pistol Range was an essential feature of the design.

(8) Fire Protection System

In this feature, as in guarding, Hercules had the benefit of their own organization and experience. Some restrictions and requirements, especially as to sprinklers in certain Non-explosive buildings, and as to the amount of water on the plant in the elevated water tanks and in the ground-level Gunite tanks, were imposed by the Ordnance Department. A special feature of the Fire Station was the tower for drying hose, which provided for quick drying away from the sunlight. Darkness and coolness are conductive to longevity in rubber. Also, the drying of hose flat brings about creases and, eventually, cracks in the rubber lining.

(9) Safety

This predominant requirement, affecting every feature of the design, received special attention from inception to conclusion. The long experience of Hercules, tempered by the tragic explosion at their Kenvil Plant in September, 1940, caused them to scrutinize every detail with reference to safety. As a result of this sort of designing and a corresponding attitude on the part of management and workers in production, no fatal accidents, as a result of occupational activities, occurred during the nearly two years of operation. The most serious accident was a leg fracture. No accidents of any sort were due to explosives.

(10) Water Supply

When the site had to be shifted to the east side of Route 100,

the terrain moved into proved to have numerous springs* which were expected to provide plenty of water. Requirements were mostly for drinking, sanitation, steam, and laundry purposes. Steam demands were entirely for heating, laundry, and dyeing, because power was to be purchased. No process water was used.

The springs, gauged for flow, proved not to have the capacity shown by records which had been believed to be reliable. The contract called for adherence to the sanitary requirements of the Virginia State Board of Health; therefore, their engineers were called into consultation. After careful surveys they stated that none of the spring water would be acceptable without complete treatment. Meantime, it had been found that the cost of impounding the separate springs and collecting the water at a central point for treatment would be considerable. Hercules recommended that New River (dammed by Appalachian Power Company to form Claytor Lake), about 1-1/3 miles from the plant's south border, should be the water supply. When this was approved by the Ordnance Department, the Main Pumping Station was placed at the lake at an elevation of approximately 1850'.

Here again the engineering facilities of Hercules Powder Company were utilized. Two sanitary engineers from the Home Office went to New

* Hercules and Government engineers disagreed on what would be the best water supply. Flow tests on various springs were performed and later wells were tried. After other means were exhausted for the supply of water, Hercules' original suggestion that water be pumped from the New River was approved and put into effect.

River Ordnance Plant and designed the Water Supply System and the Sewage Treatment System. One remained to supervise installation, initiate operation, and train attendants.

The resultant design comprised two units, the Pumping Station at Claytor Lake and the Treatment Unit within the plant. The Pumping Station consisted of five pumping units. Two pumps (one was a stand-by) were for 350 gpm. each. Three were emergency fire pumps, 1,000 gpm. each. This 3,000 gpm. possible total was an Ordnance requirement. It was out of proportion to the Fire Department personnel, which consisted of a maximum of thirty-four total for all three shifts. These fire pumps were intended to function only in case of depletion of the 1,300,000-gals. storage of treated water.

If these pumps had been utilized, the entire plant water system would have been contaminated since the Filter Plant and the operating tanks were to be by-passed and raw water fed directly into the suction of fire pumps at the Pumping Station and the Filter Plant.

The Treating Station comprised chemical feeders, flocculators, sedimentation tanks, filters, chlorinators, and ph correctors. From the ph correctors the water flowed to two circular, dome-covered Gunite reservoirs, each of 500,000-gal. capacity. Two 350-gpm. service pumps (one a stand-by) and three 1,000 gpm., dual-drive fire pumps were attached to the reservoirs. A valved by-pass with a loose section of pipe provided, in case of emergency, for pumping raw water around the Treating Plant from the lake directly into the reservoirs.

At the highest points in the plant, about 6,000 ft. apart, there

were located two elevated water tanks, each of 150,000-gals. capacity. These were approximately 195' from ground to top, supplying a static pressure of approximately 75-85 lbs. per square inch to hydrants nearby. Hydrants farther away, being lower, had greater static pressures to compensate for friction under maximum flow. This arrangement provided ample water for sprinklers and for hydrants until the fire pumps could be started. A check-valve opening away from each tank, with a service-water by-pass, provided against flooding the tanks after the fire pumps functioned. There were approximately eighty-five fire hydrants.

There were approximately eleven miles of water pipe. Cast-iron piping, steel piping, and spiral-weld steel piping were used as dictated by availability and economy for each kind.

(11) Sewage Treatment Plant

This comprised bar screens, equalization chamber, Dorr clarigester, sludge drying beds, and chlorinator. Pre-chlorination was used, as well as effluent chlorination. Domestic sewage was the principal factor, a small amount of dye wastes occasionally occurring. The chlorinated effluent fell into Claytor Lake approximately 2.3 miles below the water intake.

There were approximately nine miles of terra-cotta sewer pipe.

(12) Electric Power, Light, and Heat

No Power House was provided, because the electrical demand did not warrant generating the current. Power was purchased at 33,000 volts and transformed to 23,000 volts for distribution throughout the plant. This amounted to 3 cents for power and 1 cent for lighting. The ultimate

power and lighting load was approximately 1200 K.V.A. There was no such demand for process steam as would make low-pressure steam a profitable by-product of power generation. The buildings were so scattered that central heating, except for the Shop and Warehouse Area and the group of Staff Houses, was impracticable.

Because of a threatened shortage of fuel oil, and also on account of the plant's proximity to coal fields, coal burners were used except in the Black Powder Preparation units and in the Loading lines, where it was felt that safety as well as economy would be served by oil burners.

(13) Roads and Railroads, Internal

This was a considerable problem. Incoming inert shipments were in carloads in the same trains that brought smokeless powder. These cars had to be separated and routed to different destinations within the plant.

Two 65-ton Diesel locomotives for handling intra-plant freight cars were provided.

At the Inert Warehouses, materials had to be received from railway cars, "warehoused," and delivered to internal destinations by trucks. For this reason, the Warehouses were so designed and arranged that the tracks came in along one side and the truck roads on the other, thus straight-lining warehouse traffic.

A railroad classification yard, called the West Yard, was established, comprising all the plant property west of Route 100, about 151 acres. It was intended that N. & W. Railroad locomotives should not cross eastward over the railroad bridge spanning Route 100. (Later in operations, these locomotives did enter the plant, for greater facility

in handling freight.)

There were 9.4 miles of railroad in the plant site.

Distribution of inert materials was done by trucks, and of explosives, by truck trailers. The reason for the latter was that the safety of loading and unloading of explosives was enhanced by removing the tractor from the trailer to a safe distance. This also decreased the man-hour exposure factor. Also, the time of loading and unloading was such as to release a tractor to handle other trailers that were ready to be moved. The ratio of tractors to trailers was 1 to 5. The prime movers handling inert materials were gasoline engines; the tractors, and Diesel engines.

It was necessary to move some 550 persons per shift into the Bag Loading, Igloo, and Black Powder areas. Fourteen busses were purchased from the recently defunct New York World's Fair for this purpose.

Plant guarding required patrol roads. It was intended that this would be done by motorcycles with sidecars, and hence the patrol roads were made nine-ft. wide. Later, patrol cars were used, but the nine-ft. roadway was sufficient, because all patrol traffic moved in one direction. These patrol roads were based upon asphalted clay, (called "stabilized earth base"), with a surface of stone chips and dust penetrated with asphalt.

All other roads were of broken stone and asphalt compositions of penetration construction. The details of composition and construction depended upon the loads they would have to carry.

Two systems of roads were insisted upon by Ordnance: one for personnel and one for transportation of powder.

The roads constructed were as follows:

9-ft. road	10.84 miles
12-ft. road	7.28 miles
18-ft. road	28.79 miles
24-ft. road	11.72 miles
30-ft. road	3.46 miles
Total	62.09 miles

The maximum road grade permissible was 6%. (Actually the maximum road grade was 5.27%.)

One restriction in road lay-out that proved to be quite trying was an Ordnance requirement that a road going past any building containing explosives must neither be dead-ended nor looped around that building, but must have a separate exit--not passing that building. This was to provide against trapping personnel or loads in case of explosion or fire. It proved a difficult condition in that hilly country, with a 6% controlling grade. Another necessity was a level stretch of road of fifty ft. in front of each Igloo for parking the trailers when loading or unloading. This had to be fifty ft. off from the main traffic road, which fact accounted for the oval loop in front of each Igloo.

The later-built Magazines did not have this fifty-ft. distance requirement from the main road, and in most of these cases, simple turn-outs were used. Other safety requirements were likewise waived, as is evidenced by the map of the new Magazine Sector.

(14) Fencing

The whole property was surrounded with a four-ft., four-strand

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barbed-wire fence, and inside it there was a six-ft. chain-link fence with three strands of barbed wire at the top surrounding the "Guarded Area" and the area comprising the Shops, Inert Warehouses, Bag Factory, and Change Houses. There were approximately 12-1/2 miles of cyclone fence, seven ft. high.

(15) Housing, Staff Residences

The Staff Residences were entirely dictated by the Quartermaster Corps. Hercules prepared complete designs which were discarded in favor of others prepared by an "architect-consultant." The number was reduced at last to 15, of which 7 were for the Army or its civilian employees. A central heating unit served this group. The houses were rented to the Hercules Staff and Government civilian employees.

(16) Hospital Facilities

After many false motions, because of Government directives of contradictory nature, Hercules was permitted to design the Hospital. Meantime, pre-employment examinations were being conducted, and space had to be provided in the Hercules Employment Building. The Hospital was located north of the Administration buildings, and was equipped with a modern surgery and dispensary, eight beds, and room for twenty emergency cots in the basement.

(17) Cafeteria

A Cafeteria fully equipped for 300 places was designed. Lunches, coffee, milk, and soft drinks were distributed from this center to the various Canteens and other centers far removed from the Cafeteria.

(18) Recreation

All facilities for planned recreation were deleted from the

original plans and estimate before the contract was signed. The U.S.O. in Pulaski and in Dublin supplied some recreation, and later the structure that served as Mason & Hanger's old Employment Building was remodeled and used for a Recreation Hall under the supervision and control of an employees' association. A set of four bowling alleys was provided and installed by the Government, and the association provided billiard and table tennis equipment. A baseball diamond and a softball diamond as well as tennis courts were constructed.

(19) Maintenance Shops

The planning of maintenance on a unique job is usually difficult but in this case, for the most part, standard machinery was used--that is, sewing machines, motors, automobiles, Diesel engines, and pumps. From experience and by consultation with the manufacturers, it was possible to plan appropriate shops and equipment. A former Singer Sewing Machine Company foreman was of special help in that division, which he headed as a Hercules employee.

In the original set-up the maintenance of scales and sewing machines was under the control of the production supervisor and later under the plant engineer. Combined Shops was always under the plant engineer.

b. Specifications

Specifications were prepared by the Design Division, and, as their character warranted, were referred to manufacturer's representatives for revision in deference to attainability of materials, time of delivery, or other substitutes dictated by practicability. Where such scrutiny was pertinent, they were referred to the Safety Division. Also, Hercules

SECTION II

Auxiliary or Service Organizations

house male workers in one building and female workers in another building. Both of these buildings were located near the entrance to the plant and were separated by a distance of about twenty-five yards. When the plant was placed in a stand-by condition during May, 1943, with approximately 325 employees left on the plant, the building which had previously been used as a Women's Change House was vacated, and the lockers were removed. The building formerly used as a Men's Change House was partitioned and used for change-house purposes for both men and women. The building used as a Women's Change House was converted into temporary administration quarters during December, 1943.

During June, 1944, when additional lockers were needed, it was found that the combination-locked-type lockers were not available, and it was therefore necessary to secure key-locked-type lockers. It was ascertained, from a legal standpoint, that it would be impossible to charge employees a deposit for keys issued to them for their lockers, and as a result, quite a bit of confusion and headaches resulted. It is recommended that wherever humanly possible that no key-locked-type lockers ever be used but that combination-type lockers be used instead.

5. Motor Pool

a. Introduction

On February 1, 1942, Hercules formally took over the operation of the Motor Pool, which prior to that date had been operated under the directions of the Ordnance Department.

b. Responsibilities

The supervisor of Motor Pool was charged with the responsibility of keeping a record of the make, model, serial number, and location of all equipment permanently assigned.

At the time Headquarters was moved to the Service Station, the supervisor of Motor Pool assumed the responsibilities of that service, which responsibilities included the requisitioning of all gasoline, motor oil, and fuel oil. All automotive equipment reported to the Service Station twice each week for a check of tires, oil, and radiators. Records were kept to indicate those checked, and it was the responsibility of the supervisor to see that all were checked.

c. Organization

The Motor Pool functioned under the directions of the service superintendent with a supervisor in direct charge.

All drivers of Motor Pool vehicles for the Ordnance Department were transferred to Hercules pay roll.

d. Equipment

Prior to the time Hercules took over operation of the Motor Pool, a list of estimated motor-equipment needs for operation was submitted to the Ordnance Department, and by April 28, 1942, there had been officially transferred to Hercules the following: 17 sedans, 27 station wagons, 37 pick-up trucks, 18 stake-body trucks, 11 dump trucks, 3 lumber trucks, 3 tank trucks, 1 mixer truck, 1 rigger's truck, 1 linesman truck, 1 tar truck, 1 truck crane, 2 fire trucks, 1 grease truck, 1 ambulance, 4 motorcycles, 14 busses, 6 Mack vans, 6 Mack tractors, 1 Mack fuel truck, and 25 powder trailers - making a total of 181 vehicles.

At that time, in addition to the above, the following equipment was retained by the Ordnance Department: 8 sedans, 3 station wagons, 9 pick-up trucks, and 1 stake-body truck - making a total of 21 vehicles.

All equipment was permanently assigned to the various operating departments or to key personnel, excepting a limited number of sedans and

station wagons that were necessary to handle the numerous calls to take employees from one section of the plant to another. Regular bus schedules through the plant reduced these calls to a great extent, and unnecessary calls were further curbed by limiting authority to order pool cars to various department heads and key personnel.

e. Headquarters

At the time Hercules took over, the Motor Pool was being operated from the Garage. In March, 1942, Headquarters was moved inside of the Guarded Area. There was no further change until May, 1943, at which time Headquarters was moved to the Service Station.

f. Reduction in Force

In May, 1943, production ceased and the plant was ordered into a standby condition. At that time women who had been working on the Loading lines took over the driving duties on the day shift, and only two male drivers were retained for each of the other two shifts.

g. Activities under Radford Ordnance Works

On September 19, 1943, Radford Ordnance Works formally took over operation of the New River Ordnance Plant, and activities at the plant increased rapidly, preparatory for increased work at the plant.

By December 31, 1944, much automotive equipment previously transferred to the Ordnance Department had either been returned to Hercules or replaced. A total of 193 pieces of equipment was under the supervision of the Motor Pool, including 28 sedans and 12 station wagons. All of this equipment was permanently assigned with the exception of 5 sedans and 2 station wagons, which were retained by the Motor Pool for the handling of pool-car calls.

At that date, the Pool was being operated by 19 hourly employees and 2 salary employees.

complete applications would be sent to the Personnel Department for consideration in selecting and staffing the plant. The offices designated in this area to assist in this work were as follows: Roanoke, Radford, Pulaski, Galax, Marion, and Bristol, Virginia.

Previously Mr. George R. Foulke, Jr., assistant plant manager, had contacted the Virginia State Employment Service regarding personnel needs, occupational studies, etc., necessary for the operation of the New River Ordnance Plant. Mr. George G. Painter of the Home Office at Richmond, Virginia, Federal Security Agency, Social Security Board, Bureau of Employment Security, Employment Service Division, was assigned to make a preliminary occupational survey for the loading of artillery bags. Mr. Painter, an occupational analyst with the Virginia State Employment Service, made his survey at Picatinny Arsenal. The information developed was very valuable from a standpoint of preliminary information, and was at that time turned over to the Personnel Department with the comment from Mr. Foulke: "Let this be your bible."

b. Occupational Survey

A verbatim copy follows of the results of the occupational survey conducted at Picatinny Arsenal, Dover, New Jersey, for the New River Plant. This survey was conducted and written up by Mr. George G. Painter, of the Virginia State Employment Service.

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Federal Security Agency
Social Security Board
Bureau of Employment Security
United States Employment Service Division

PRELIMINARY

OCCUPATIONAL SURVEY

for the

LOADING OF ARTILLERY BAGS (Propellant Charges)

(Based on limited coverage in only one area. Necessary revisions will be made after further sampling)

March 14, 1941

Occupational Analysis Section
Plans and Services Unit

PSSD-36

PROCESSES AND OCCUPATIONS INVOLVED IN THE LOADING OF ARTILLERY BAGS

The cloth from which the bags are made is brought into the propellant charge section in large rolls, approximately 100 yards in length and 2 yards wide. The cloth is first passed through a cloth washing-machine (Cloth-Washer Operator, 6-19.262), then a cloth dyeing machine (Dyeing-Machine Tender, 7-18.050), and finally, a cloth drying machine (Cloth Drier, 6-19.411). The cloth after having been dyed the proper color is then pressed (Presser, Machine I, 7-57.511) and relayed to the cutting room where it is stretched out in layers on long cutting tables by means of an automatic laying-up machine (Cutter Machine I, 6-27.054).

After the cloth is laid up, it is marked for cutting and cut by means of motor-powered cutting knives of circular or straight reciprocating design (Cutter, Machine I, 6-27.054). Some of the cut pieces are then brought to the print shop where they are imprinted with numbers which indicate what charges are to be contained therein (Ticket Printer, 6-44.010). The printing equipment employed is identical with the machinery found in the ordinary shop printing establishment, there being no special printing press required for printing cloth as contrasted with paper.

All the cut pieces of cloth are then brought to the sewing-room where they are sewed on electric-powered sewing machines into bags of various sizes (Sewing-Machine Operator (Textile Bag), 6-27.523). In the assembly process, the bags are left partially open so that the charge may be poured into them. The bags take a variety of shapes and sizes according to the type of charge or the type of gun for which the charge is intended.

In the loading of bags containing smokeless powder, as distinguished from igniter charges which are loaded with black powder, the charges of explosives are measured out by volumetric measuring machines. These machines cannot be used for charges weighing less than four ounces. The charge of smokeless powder which is measured out by the volumetric machine is then weighed on a shadowgraph scale (Explosives Operator II, 8-52.42). This special weighing device reaches a balance in a matter of seconds and thus speeds up the weighing of charges considerably. Each charge is then check-weighed on a similar set of scales (Explosives Operator II, 8-52.42). The explosive charge is then poured into the proper bag (Explosives Operator II, 8-52.42), and is then passed on to be sewed and sealed on an electric-powered sewing machine (Explosives Operator II, 8-52.42).

These five operations of volumetric weighing, shadowgraph weighing, check-weighing, loading, and sewing up of bags are performed by a group of 5 workers working in separate rooms. This is done in the interest of safety so that a mishap in one unit will not endanger the working of other sections. The completed bags are then passed through a central receiving room from each of the small loading rooms where the bags are inspected and the production records of each loading room kept (Explosives Operator II, 8-52.42).

In the loading of the igniter charges, the black powder is measured out with the use of measuring cups. It has been found that volumetric measuring devices as are used in smokeless powder cannot be satisfactorily used for this type of loading. A 10% sample of the charges so measured is then check-weighed and the black powder poured into the bags. All the above operations on black powder are performed by one worker (Explosives Operator II, 8-52.42). The bags are then taken to another room to be sewed (Explosives Operator II, 8-52.42). In the assembly and packing rooms, bags of various sizes are combined to form the complete charge. The various sizes of bags to be assembled into a complete charge depend upon the type of gun in which the charge is to be used (Munitions Handler, 8-52.42). In the manufacture of charges for the 105 mm. and 75 mm. Howitzers, igniter charges are not used, but in all other cases an igniter charge is assembled with other bags. In the complete assembled charge there are usually three to seven bags, including the bag containing the igniter charge. Each assembly of bags is then "Puttied" by a machine which tightly wraps into a solid-self-contained unit (Puttying-Maching Operator, 6-52.456). An igniter protector is then put over the igniter charge, the cover is put on and the munitions data log attached (Munitions Handler, 8-52.42). In the production of charges or bags requiring large-grain powder, there is a special powder stacking machine used which stacks the powder capsules so as to permit the greatest number being placed in any given area. This machine is used only for 8" to 16" gun charges and is therefore not in constant operation (Powder-Stacking-Machine Operator, 6-52.455).

either enlisted or who had been drafted into the armed forces from New River. When this plant was taken over and made an Operating Unit of Radford on September 19, 1943, a duplicate file was prepared from th existing Selective Service files maintained at this plant, and it was sent to Radford in order that both plant records covering Selective Service could be combined. After that time the New River file was maintained, with duplicate records sent to Radford in each case. All final processing and handling of Selective Service records was later handled from Radford. The New River file, however, was maintained in order to have available information which was useful to departmental supervisors and others handling personnel work at this plant.

9. Inactivation of N. R. O. P.

During March, April, and May, 1943, it was definitely decided that production would cease at New River Ordnance Plant, and the indications were that this plant would be used as a Storage Depot. Production actually ceased on May 24, 1943. Prior to that time, and during March, drastic curtailment in personnel was effected. The indications were that approximately 1,500 people either would be transferred to other Hercules plants if needed or would be made available to other essential industries in this area. In this connection, therefore, quite a bit of preliminary survey work was done to determine the needs of local industries and to determine whether or not local industries could absorb the balance of employees who could not be retained or transferred to other Hercules Plants.

The United States Employment Service was contacted, and a labor survey was made to determine local needs. Other Hercules plants were contacted to determine the numbers and classes of employees who could be utilized by the company. Personnel managers were contacted by the United States Employment Service, and arrangements were made to allow local concerns, as well as

certain other concerns outside the immediate area, to come in and personally interview, in the Personnel Department, New River personnel who would be available for employment. Every effort was made to assist employees in securing gainful employment without unnecessary loss of time. Personnel Department records were made available to personnel managers and interviewers representing outside firms as an aid in making their selections.

The Hercules Powder Company Plant at Radford, Virginia, received from New River at the beginning sufficient numbers of employees through transfers to meet their needs. The Sunflower Ordnance Works at Lawrence, Kansas, accepted between 50 and 75 guards. The Hercules Powder Company Plant at Parlin, New Jersey, arranged to utilize the services of a small number of female production workers. The Hercules Powder Company Plant, Port Ewen, New York, received through transfer about 14 supervisory employees. The Volunteer Ordnance Works, Chattanooga, Tennessee, likewise secured a small number of male production workers from New River at this time.

The following plants employed many of the employees who were released at New River because of the labor surplus: the DuPont Plants at Martinsville and Richmond, Virginia, and at Penns Grove, New Jersey; the Celanese Plant, Narrows, Virginia; the National Fireworks, Inc., and the Triumph Explosives, Elkton, Maryland; the Norfolk Shipbuilding and Drydock Corporation, Norfolk, Virginia; and the Holston Ordnance Works, Kingsport, Tennessee.

In addition to the companies mentioned above a sizeable number of employees who, because of family conditions or for other reasons, did not wish to leave this immediate area migrated back to their farms and to local businesses in Pulaski County. Considerable unrest was prevalent during this period as rumors were many. However, after definite information was received and after all employees were given the full story and understood the efforts

that were being made in their behalf, the confusion was reduced to a minimum, and the situation became more tolerable.

These were heart-rending days. Friends were separated by employees' scattering to all parts of the country. Many of the male employees volunteered for military service, and others accepted commissions in both the Army and the Navy.

Meantime, however, Mr. A. R. Hance had been promoted from the position of service superintendent to general superintendent. The position of service superintendent had not been filled, and so these duties were also handled by Mr. Hance along with his new duties as general superintendent.

On June 1, 1943, Mr. W. J. Joyner was transferred from New River Ordnance Plant to the Hercules Plant at Port Ewen, New York. Miss Mary E. Werth, who up until this time had been serving as chief of the Employment Division, assumed the duties and responsibilities of all personnel functions and reported directly to Mr. A. R. Hance, general superintendent.

During the summer of 1943, the Personnel Department was kept reasonably busy. Records of all the employees who had been transferred or terminated had to be cleared. A large portion of the time was spent in transmitting data and answering questionnaires from other concerns in regard to former employees, who by this time had migrated to all parts of the country. The above-mentioned work, together with the maintenance of the usual personnel records on those persons who had remained on the plant, kept the personnel busy.

10. New River as a Unit of Radford Ordnance Works

On September 19, 1943, the contract under which the New River Ordnance Plant had been operating was cancelled, and the New River Plant was transferred to the jurisdiction of the Radford Ordnance Works and was operated on that

basis after that time.

This change-over meant that it was necessary for the Personnel Department to call in each of the 322 persons who were then on New River payrolls in order to transfer them to the payrolls of the Radford Ordnance Works. New sets of employment records, in toto, as well as new payroll numbers, had to be issued on each of these persons. Every effort was made by the Personnel Department to expedite this change-over in order that these employees might be picked up on the Radford rolls as quickly as possible.

At this time the Personnel Department at New River became part of the Service Department of Radford Ordnance Works and was under the supervision, through the general superintendent at New River, of Mr. R. H. Veale, service superintendent at Radford Ordnance Works. As a result of this consolidation of the plants, very few changes were made in the general operation of the Personnel Department at New River.

During the latter part of October, 1943, Rolled Powder Operations, which consisted of increment packaging, were begun at New River. The first group of employees who had been selected for this work entered upon their duties during the early part of November, 1943. Since the start of this operation, employment has gradually increased, and by October, 1944, approximately six hundred people per month were being employed.

On August 1, 1944, Mr. W. J. Joyner was transferred back to New River from the Port Ewen, New York, Plant in the capacity of supervisor of personnel.

During the reactivation of this plant, the labor supply in the immediate area was near the exhaustion point. Male employees were being procured at about the same rate as female employees. Neither, however, were available in as large quantities as was needed. Absenteeism and labor turn-over

rates were steadily climbing. During October, 1944, the department was advised by the War Manpower Commission that colored applicants were available in sufficient numbers within commuting distance of the plant to guarantee the operation of one unit on a full-time basis. As a result, after considerable planning, colored workers of both sexes were employed for work on production jobs during December, 1944. By the close of 1944, there were approximately eight hundred colored workers on production work at the plant, and one 105 MM. Line was being operated on a three-shift basis by colored employees. It is impossible at this time to give any definite facts regarding the production attained or the effects of the use of colored workers on this type of work.

a. Recent Recruitment Program at N.R.O.P.

During September, 1944, the labor supply in the immediate area had become so acute that it was necessary to recruit workers from outside the immediate area. Labor recruiters were hired and after proper training were used for this purpose. Clearance orders were prepared by the department and handled through the War Manpower Commission in order for the plant to procure labor in compliance with existing regulations. After that time, a number of workers were sent in from neighboring states. The transportation expenses to the plant covering these workers were paid by the company, and in rejected cases transportation expenses were paid by Hercules back to the places of recruitment.

The labor turn-over figures covering workers recruited from the outside areas were relatively large. Outside recruiting, in the main, proved very unsatisfactory. There was nothing, however, that could be done to correct this condition inasmuch as the bottom of the barrel had been scraped in the immediate area before outside recruitment was started.

Chapter XI

FIRE DEPARTMENT

1. Organization

Mr. Earl H. Cain, a former lieutenant of the New York Fire Department, was hired May 10, 1941, soon after construction was under way and was given the title of "fire chief." He was under the supervision of Mr. J. B. McNabb, service superintendent, and the two together supervised the organizing and operating of the Fire Department.

Nine applicants were investigated and hired during the month of June, 1941, the first six being hired on June 10. By October 1, the personnel had increased to 25 and by December 1, 1941, to 34, consisting of the chief, 3 lieutenants, 6 motor-pump operators, and 24 firemen.

On August 1, 1942, Lieutenant Vernon C. Thompson was appointed to succeed Chief Earl H. Cain, whose death occurred July 12, 1942. Chief Thompson came to New River from the Radford Ordnance Works on June 19, 1941.

A personnel average of 34 was maintained until April, 1943, at which time the department was reduced by 6 firemen. Two motor-pump operators were terminated prior to September 18, 1943, on which date Radford Ordnance Works took over the operation of this plant. On December 31, 1944, the total personnel was 26.

2. Quarters

The first Fire Station was in one side of Mason & Hanger's Tractor Shed. On August 10, 1941, the Fire Department took possession of their permanent quarters, which was a one-story frame building, located in the Inert Area on Baker Road between Second and Third streets.

Rectangular in shape, it faced the west and was 88' in width by 34' in depth.

HERCULES POWDER CO.

NEW RIVER ORDNANCE PLANT

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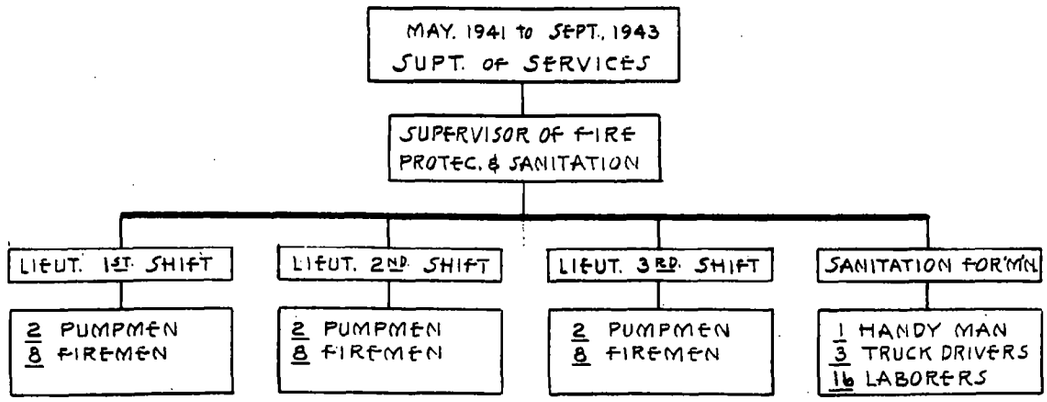
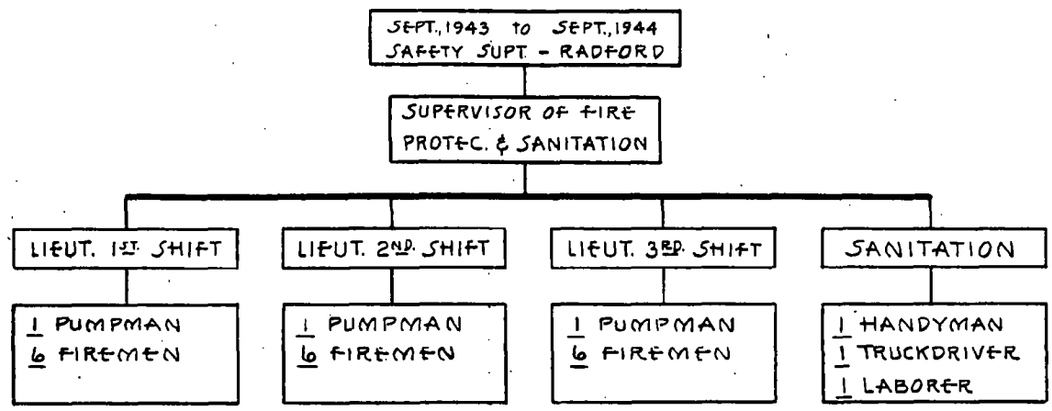
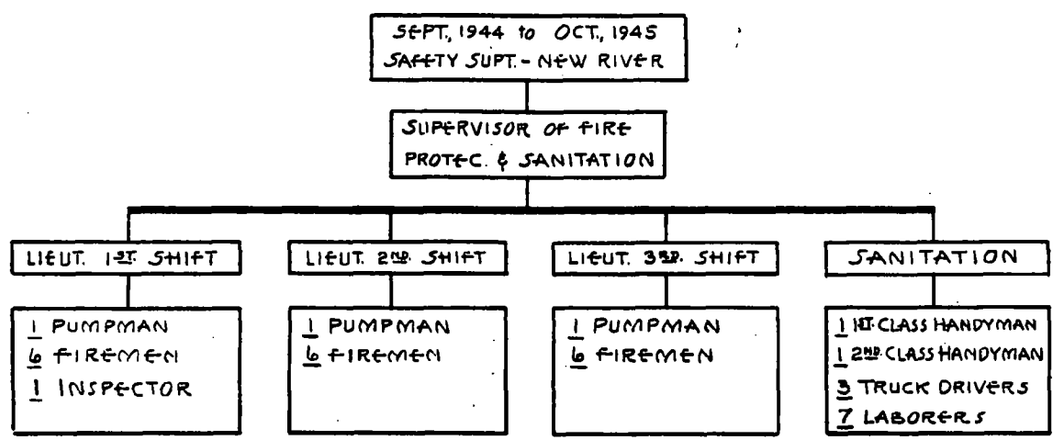
ORGANIZATION CHARTS
FIRE DEPARTMENT
1941 - 1945







The Engine Room, 35' by 34', was situated at the south end of the building and consisted of 2 stalls with sufficient width for 3 pieces of equipment. Each stall was equipped with floor drains, and the room had two quick-opening spring doors. At the rear or east side of the Engine Room was a hose tower, 55' high, which accomodated fifty-two sections or 2600' of hose.

Adjoining the Engine Room and on the west or front side was the House Watch Room. "House watch" was made in two-hour shifts, and one man was on duty at all hours. The main entrance to the Fire Department led into this room, which also had entrance into the Chief's Office. The Locker and Lounging Room was in the northwest corner.

Two rooms on the east side or rear of the building were used for storing equipment, one adjoining the Engine Room and the other was in the northeast corner. Between the two Equipment rooms were located the Boiler Room and the Rest Room.

3. Fire Department Personnel and Strength

The graph on page 235 shows the Fire Department personnel strength for the entire period.

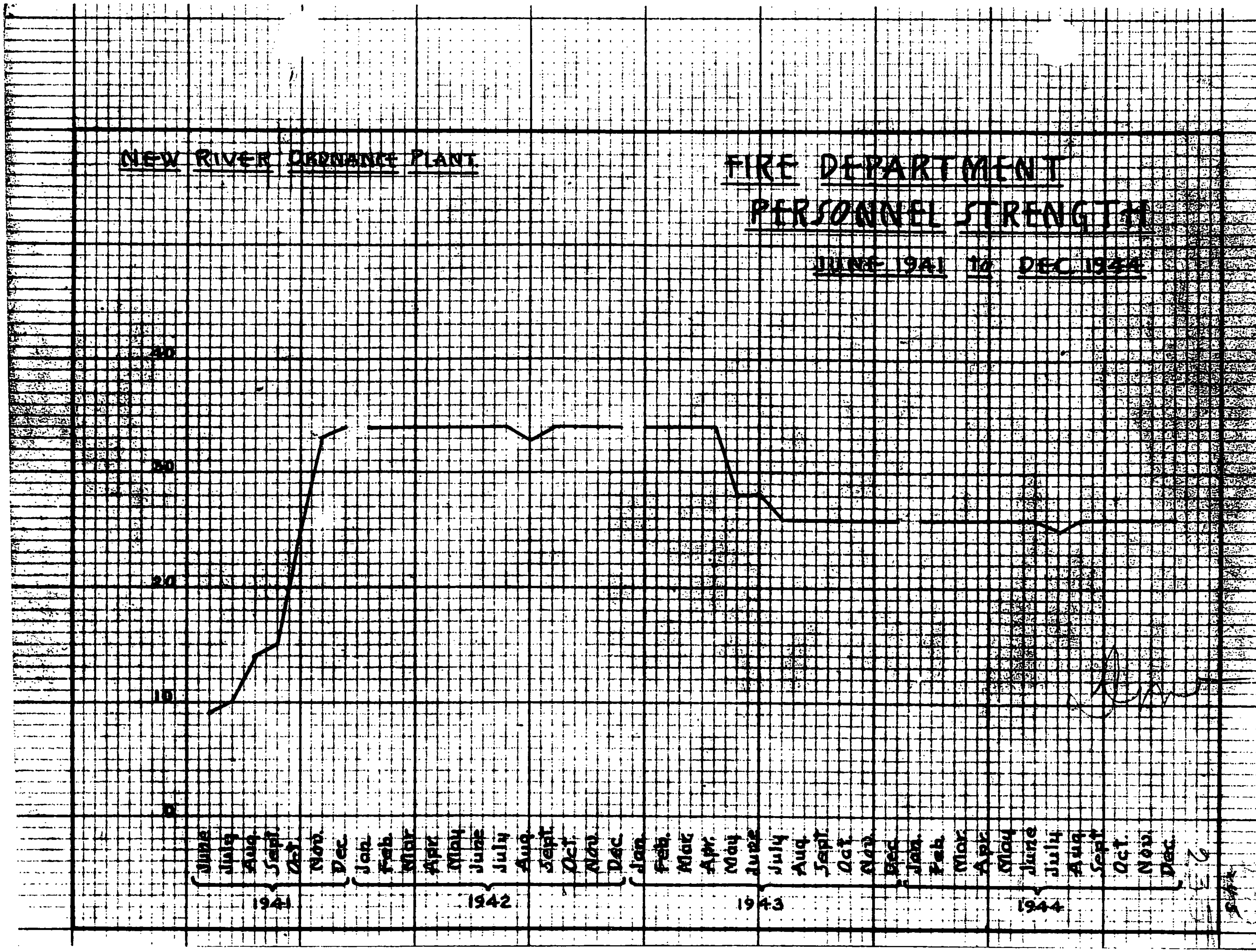
4. Planning Fire Protection

Immediately after assuming charge, Chief Cain made several thorough inspections of the plant, submitting his recommendations for the elimination of minor hazards and safety violations.

During the last two weeks of May, 1941, Chief Cain visited the Home Office of Hercules, Picatinny Arsenal, and the Hercules plants at Kenvil and Parlin, New Jersey. Each plant was inspected and plant protection in detail was discussed with safety and fire officials.

In October, 1941, Mr. Frank V. Tuthill of the Jefferson National Forest,

ORIGINAL (Red)



U. S. Forest Service, submitted a composite report and plan of action for fire control, which was based on an intensive reconnaissance of the entire Plant Area.

Collaborating with Mr. Tuthill were Lieutenant J. B. Wilkes, safety officer, Ordnance Department; Mr. Leland Wilson, U. S. Army engineer, in charge of construction; and Fire Chief Earl H. Cain.

Prevention, preparedness, and suppression were the three major divisions of activity covered in this report.

a. Prevention

Prevention was subdivided into six classifications of risks, which appeared to be present on the Plant Area.

(1) Risk No. 1: Plant Personnel and Visitors

Rigid restrictions were planned and enforced. No smoking was permitted within the Guarded Area except at specified periods and at designated places under Radford Ordnance Works supervision. After September 18, 1943, smoking within the Guarded Area was discontinued. Automatic dismissal was the penalty for violations of this rule.

Firearms were carried by plant guards and where the use of matches was necessary, they were furnished by the Fire Department and carried in safety match containers. With these exceptions, no firearms, matches, or other fire-causing implements were permitted. Violations were subject to suspension or dismissal.

Visitors had to have a pass and were subject to the same restrictions as employees.

(2) Risk No. 2: Plant Railroad

This hazard was adequately safeguarded by the purchase of two 65-ton Diesel electric locomotives. One of these locomotives was shipped

August 26, 1943, to the Ozark Ordnance Works.

(3) Risk No. 3: Adjacent Property Owners

This class of risk appeared to afford a major opportunity for trouble, since little control was available and fires on adjoining land could easily spread to the Plant Area.

As a safeguard against this hazard, adjoining property owners were requested to take adequate precaution in case of fire on their property to prevent its spread to Government land.

Fire patrols were established and fire barrels and water pails were placed at strategic points in the Igloo Area. (The use of these was discontinued in the summer of 1943.)

(4) Risk No. 4: Incendiary

The possibility always existed of having fire deliberately set with malicious intent. An ever-alert Guard Force, patrolling the Plant Area day and night, has been and is the preparation against this hazard.

(5) Risk No. 5: Debris Burning

Construction shacks and debris accumulated from construction activities were burned under the supervision of the Fire Department during the month of December, 1941.

Scrap and rejected powder was delivered to the burning grounds by a magazine employee and was burned daily by the Fire Department, who had been previously notified as to the exact time it would arrive.

In January, 1942, the Fire Department assumed charge of the Sanitation Department, its equipment and personnel. This department gathered all garbage and destroyed same in the incinerator, which was housed in a two-story cinder block building located on the south side of Stanton Road, approximately two hundred yards east of Baker Road.

(6) Risk No. 6: Lightning

Available information indicated that lightning struck frequently in the Plant Area.

Numerous dead trees and old farm dwellings and buildings, which attract lightning, were destroyed. All buildings were thoroughly grounded, and to date neither fires nor property damage has resulted from lightning.

b. Preparedness

Detection, communication, manpower, and equipment were prime factors considered in planning preparedness.

(1) Detection

Since the Guard Road ran on ridges and generally overlooked the area, any fire could be detected by guards patrolling this road.

A Fire Patrol on the 4-to-12 and 12-to-8 shifts was established July, 1941, and continued until construction was completed. This patrol used a pick-up truck, equipped with fire extinguishers, and covered the entire Plant Area during the night hours.

Daily inspections of the plant were made since the hiring of the first firemen in June, 1941.

The Forest Service Lookout at Peaks Knob was instructed to notify plant officials of any fire that appeared in the vicinity of the Plant Area.

(2) Communication

Early in 1942 all patrol cars were equipped with two-way radio communication. This radio communication system together with phone service in practically every building throughout the entire Plant Area were considered adequate.

Chapter XI

FIRE DEPARTMENT

1. Organization

Mr. Earl H. Cain, a former lieutenant of the New York Fire Department, was hired May 10, 1941, soon after construction was under way and was given the title of "fire chief." He was under the supervision of Mr. J. B. McNabb, service superintendent, and the two together supervised the organizing and operating of the Fire Department.

Nine applicants were investigated and hired during the month of June, 1941, the first six being hired on June 10. By October 1, the personnel had increased to 25 and by December 1, 1941, to 34, consisting of the chief, 3 lieutenants, 6 motor-pump operators, and 24 firemen.

On August 1, 1942, Lieutenant Vernon C. Thompson was appointed to succeed Chief Earl H. Cain, whose death occurred July 12, 1942. Chief Thompson came to New River from the Radford Ordnance Works on June 19, 1941.

A personnel average of 34 was maintained until April, 1943, at which time the department was reduced by 6 firemen. Two motor-pump operators were terminated prior to September 18, 1943, on which date Radford Ordnance Works took over the operation of this plant. On December 31, 1944, the total personnel was 26.

2. Quarters

The first Fire Station was in one side of Mason & Hanger's Tractor Shed. On August 10, 1941, the Fire Department took possession of their permanent quarters, which was a one-story frame building, located in the Inert Area on Baker Road between Second and Third streets.

Rectangular in shape, it faced the west and was 88' in width by 34' in depth.

for the expenditure. The reimbursement checks received from the Government were deposited in the special account. Thus the Government advances to Hercules served as revolving funds.

6. Stores

a. Introduction

Preparations for handling and recording the vast quantities of materials and supplies that were used at New River Ordnance Plant began April 1, 1941, when Mr. Robert A. Bryson was transferred from the New Jersey Powder Company, Belvidere, New Jersey, to be chief clerk of Works Supply, which was divided into two sections, namely, Warehousing and Accounting.

b. Facilities

The construction of thirteen Inert Storage Warehouses began April 8, 1941. These buildings, numbered 101 through 113, were utilized as completed and all were accepted as complete September 1, 1941.

The buildings were well planned and arranged. They were long, spacious rectangular buildings so designed and arranged that the railroad came along one side, the truck road on the other, thus facilitating warehouse traffic.

Construction of Warehouse 207 started May 22, 1941, and was completed October 22, 1941. This warehouse, 48 ft. by 183 ft., was constructed for "warehousing" general-stores items. The design of the building included two offices in the south corner.

Warehouse 208 was constructed for use as a storage warehouse for paints and oils.

7. Ordnance Department - Storage and Issue

Of historical interest is the fact that New River Ordnance Plant had

two Receiving departments. From the beginning and until termination of Contract W-ORD-492, the Ordnance Department received and stored such materials as tires, tubes, batteries, antifreeze and furniture. These items were issued to Hercules on store-order tickets which were consolidated and recorded on NR transfer receiving reports.

Prior to March 1, 1942, the War Department received, stored, and issued all automotive and truck parts. On that date the balance remaining on hand was tallied out to Hercules.

Excepting wood blocks and a few miscellaneous items purchased by Hercules, the Ordnance Department received on a free-issue basis all essential materials until March 1, 1942. These essential materials were issued to Hercules on store tickets properly signed.

8. Hercules Warehousing

a. Headquarters

Office quarters for the Warehousing Section of Works Supply was first located in Warehouse 101. This warehouse also served as Hercules' first Receiving Station. On January 1, 1942, Headquarters was moved to Warehouse 207, which had been constructed for that purpose.

On March 1, 1942, Hercules took over all warehouses except one-half of Warehouse No. 106.

b. Responsibilities

(1) Receiving

After March 1, 1942, all materials and supplies used in the operation and maintenance of New River Ordnance Plant were covered by receiving reports prepared by the Warehousing Section of Works Supply. Items purchased direct by the Ordnance Department were tallied out to Hercules and received by

them on NR transfer receiving reports.

General Stores consisted of several departments, each handling special-store items, such as, auto parts, clothing, electrical equipment, janitors' supplies, lumber, and plumbing supplies. Each department was in charge of a man who had previous experience in handling items stocked by his department. An average of from 5,000 to 6,000 issues from stock was made monthly. Approximately 15,000 items were carried in stock. Approximately 125 carloads of essential materials and approximately 12 cars of miscellaneous materials were received monthly.

The Transportation Division of the Ordnance Department was notified of any shipments found to be damaged on delivery, and they in turn notified the carrier effecting delivery. The certificate-of-inspection report was prepared and signed by the storekeeper or his assistant and by the transportation agent making the inspection. This report was forwarded to the Purchasing Department who handled any claim to a conclusion.

At the termination of the construction contract, January 31, 1942, Hercules agreed to take over all surplus equipment, materials, and supplies. Materials and supplies were checked out of Mason & Hanger's Warehouses by checkers for Mason & Hanger, the Ordnance Department, and Hercules, and were transferred to the custody of Hercules. In some cases Hercules took over all the warehouses used by Mason & Hanger, thus effecting a saving in handling of material.

(2) Storage and Issue

General Stores:

Storage and issue of all material charged to 16500 supplies was handled by the Warehousing Section of Works Supply.

After the receiving report had been prepared, the supplies were turned over to the department stocking the particular items received. Recording of necessary information on the bin card was done at the time material was put in stock. When completed, the bin card showed bin-code number, description of item, maximum and minimum quantities, requisitions, material-list numbers, purchase orders, receiving-report numbers, account charged to when issued, balance on hand, and dates of all transactions.

Essential Materials:

After March 1, 1942, storage and issue of all essential materials used in the manufacturing of finished charges was handled by this section. Whenever possible, essential materials were delivered to Warehouse 103, which was assigned to the loading line supervisor.

Bin cards for each type of essential materials were kept in the warehouse in which the items were stored. Bin cards reflected quantities received, quantity issued, balance on hand, and dates of all transactions. These materials were issued on warehouse orders prepared in duplicate. One copy was retained by the Warehouse Section and the second copy picked up for the General Division. Inventories of all essential materials were made monthly.

(3) Shipping

All shipments of by-products, returned material, and all other shipments with the exception of powder and finished charges were handled by the Warehousing Section. No shipments were made without proper authority and approval by department heads. The Purchasing Department prepared the shipping order, which listed complete shipping instructions together with charge and billing information. To support the shipping order that required Ordnance Department approval, the warehouse prepared a shipping report that gave a

description of materials in complete detail. The shipping report was signed by a material checker for both the Ordnance Department and Hercules.

Any materials turned back to the Ordnance Department were recorded in the same manner as a shipment to an outside concern. The Ordnance Department prepared tally-in sheets of materials transferred back to the Ordnance Department on shipping reports.

The Ordnance Department handled the shipping of all powder and finished charges until September 19, 1943, which date marked the beginning of the Radford Ordnance Works Contract at New River and at which time the Shipping Department of the Warehousing Section began to handle all shipments.

(4) Salvage

All material salvaged whether or not sold by Hercules, used by Hercules, or turned over to the Ordnance Department Property Section was handled through General Stores and recorded by the Warehousing Section.

9. Materials and Supplies (Works Accounting)

a. General

The primary function of this section was the auditing and approving for payment all vendors' invoices prepared on company forms, carriers' freight bills, travel expense reports, etc. The operation of the Stationery Storeroom for the entire plant was also a function of this section.

b. Invoice Audit

Procedures for the audit and for the approval of expenditures were based on standard Hercules' methods.

In so far as possible, personnel was secured for audit purposes who had a special knowledge of the material covered by the invoices which they were auditing.

SECTION III

Operations

which were rated at 40, 45, and 50 cents per hour. The 40¢ minimum was used as the entrance rate, with advancement to the higher rates available, dependent on the production achieved by each individual operator.

Maintenance rates, as well as those for all other types of work identical with that performed at the Radford Plant, were taken bodily from the Radford schedules, which had been a proved and put into effect some months before.

Salary schedules for supervisory and administrative employees were built up from these wage schedules in a manner calculated to produce a single structure which took cognizance of the differences in duties and reponsibilities of each position, and, within the rate ranges established for the salaried positions this fact was officially recognized by the Ordnance Department through its approval of the universal application of a general increase granted to the plant organization in December, 1941. Certain adjustments were necessary in the original schedule: notably, the equalization of rates paid the Guard Force and the explosives operators, in order to do away with the constant requests for transfer from the Guard Force to the Explosives Area which were encountered; but by and large experience proved the basic policy to be sound, and therefore these necessary adjustments were minor. Plant morale was of a very high order, and no labor trouble of any kind arose during the first period of operations, which ended actively in May, 1943, and finally with the termination of Contract W-ORD-492 in September of that year.

5. N. R. O. P. Transferred to Radford Contract

Change Order 15, August 11, 1943, to Contract W-ORD-462, DA-W-ORD-26 as Amended, the prime contract between Hercules Powder Company and the United States governing the operations of Radford Ordnance Works, provided that upon termination of Contract W-ORD-492, Hercules Powder Company would operate New River Ordnance Plant as a Storage Depot in connection with the operation of

Radford Ordnance Works, and would, at the same time, utilize existing facilities at New River plus any additional facilities which might be necessary for the waterproofing of double-base trench mortar increments manufactured at Radford and Hercules Powder Company's Kenvil Plant. September 19, 1943, was established as the transfer point between the two contracts, and all work done at New River since that date was covered by supplements to Contract W-ORD-462. A summary of these supplements and the change orders which preceded them is attached as "Memorandum A."

6. The Standby Period

The operation of New River under Contract W-ORD-462 falls naturally into two major parts: (1) the period from September, 1943, to July, 1944, during which operations were confined principally to the waterproofing of trench-mortar increments and the handling of powder into and out of storage; (2) the period from July, 1944, to the final termination of operations after the end of the Japanese war, during which the plant was again operated as a full-scale propellant loading facility.

During the first of these periods, all activity on the New River site was theoretically conducted under the active supervision of the Radford Organization. Wages and salaries in effect were made to conform with those paid at Radford for similar work, though the differences in the two operations made the necessary definitions extremely difficult and resulted in a large number of reductions in compensation paid to the New River personnel. With respect to the salaried supervisory personnel, it was considered necessary to centralize the activities of similar departments at the two plants under a single department head, and consequently New River's department heads were designated as assistants to the several corresponding department heads at Radford.

The record indicates that it was planned to provide for a ready interchange of labor between the two plants, but this was never extensively practiced and the policy was apparently abandoned after March, 1944. During the previous six months, only Magazine Area workers were so employed; the men assigned to the Radford Magazine Area worked a total of 699 man-days at New River. No New River employees were ever assigned to similar intermittent work at Radford. The plant population during this period averaged about 500.

7. Activities Renewed

Increased demands for cannon ammunition during the spring of 1944, culminated in the decision by the Ordnance Department to resume the loading of propellant charges at New River, and Change Order 27, dated July 5, 1944, to Contract W-ORD-462 set the capacity which was to be provided. The discussion of this change order in "Memorandum A," which forms a part of this chapter, outlines the circumstances surrounding it and the subsequent instruments which determined the manner in which the necessary work was to be done, though this discussion does not indicate in any way the difficulties which were involved in the necessary work of rehabilitation. Following the termination of Contract W-ORD-492, the bag-manufacturing and bag-loading equipment which had been used in operations under this contract had been almost entirely removed from the plant. The Operating Organization had, of course, been broken up and for fourteen months, manufacturing activity had been confined to the packaging of trench-mortar increments - an operation in no way connected with the loading of flash-reducer charges.

Just prior to the shut-down of New River's Operations in May, 1943, the incipient manpower shortage had necessitated the employment of women in Loading Operations and even though a company-wide differential of 10¢ per hour paid to female employees as such was in effect, this employment destroyed the relationship between rates paid in the Bag Manufacturing Department and in the Loading lines that had existed in 1941 and 1942. Operations during the initial period were concluded before this problem really became acute, but when plans were made for rehabilitation, active consideration of it was immediately necessary. Wage schedules were adopted and approved which provided identical entrance and intermediate rates for the two types of work, but a higher ultimate rate for work in the Loading Operations resulted in a certain amount of unrest among the workers assigned to the Bag Manufacturing Department, which unrest was never completely allayed.

By July of 1944, seventy-five sewing machines with the necessary corollary cutting and printing equipment had been set up in one section of the main Bag Manufacturing Building to produce flash-reducer bags, and a dyeing machine which had fortunately been left on the plant was again in operation. Production schedules furnished the plant by the Office of the Field Director of Ammunition Plants called for initial operation on 105 MM Howitzer charges in September and the initiation of this production, together with the scheduled loading of 155 MM Howitzer M4A1 charges, required the design and construction of completely new flash-reducer loading facilities; the redesign of two existing lines to allow dual operation in the loading of 105 MM charges; the redesign of one existing Loading Line to permit the production of 155 MM charges, a type which had never previously been produced at this plant; and the procurement of the necessary equipment. In this connection it is interesting to note that the dual layout which was first put into operation at Hoosier Ordnance Plant and which became standard in the loading of 105 MM Howitzer charges in

1944 was originally conceived and recommended to the Ordnance Department by Hercules Powder Company in 1941 at the inception of the Bag Loading Program. It was not in accord with the practice of Government-owned loading establishments, however, and its adoption was postponed until the need for cannon ammunition, which led to the rehabilitation of New River, made it of vital concern to achieve the maximum possible production from existing facilities.

a. Rehabilitation Authorized

Authority for the procurement of equipment and for the necessary construction work was not received until August 21, 1944, after the execution and acknowledgment of Change Order 29, and activity during this period was of necessity limited to obtaining such items of equipment and components as could be found in excess at other Government facilities and as could be shipped "free issue" to the New River site. In order that some production could be accomplished in as short a time as possible, every effort was made to assemble sufficient equipment in this manner to prepare one Loading House for one-way operation on 105 MM charges. The first work required of Mason & Hanger Company as the collateral contractor subsequent to the execution of Change Order 29 was the installation of this equipment in No. 3 Line. This work was accomplished with reasonable rapidity, and operations were begun on the A-Side of this line at 1:00 P. M., September 14, 1944. Supervision of construction and installation of equipment by Mason & Hanger Company was assigned to Mr. H. E. Carlin, project engineer at Radford Ordnance Works, and the procurement of the equipment from material lists prepared by the New River Engineering and Operating departments was in the hands of Mr. C. F. Jones, purchasing superintendent at Radford. Every effort was made to transfer supervisory personnel from the first New River Organization who were still in the employ of Hercules Powder Company at other plants, and these men, together with a number of others who were found to be available, provided the plant with a nucleus around which the subsequent organization was developed. It should be stated, however, that

competent supervisory personnel in the number required to handle the operations which were ultimately undertaken were never available, and the operation of the plant during 1944 and 1945 necessarily reflected this condition. Initial operations were expanded as rapidly as the difficulties encountered in the employment of workers, both for construction and operations, and as the procurement of equipment would permit. The lapse of time occasioned by the delay in the execution of proper contractual authority has already been noted, and additional delay was occasioned by the issuance of equipment priorities by the War Production Board which excepted scales and sewing machines - the two most vital items of equipment which were required.

The manpower shortage throughout the country had by this time become acute, and this situation manifested itself not only in the extreme difficulty involved in recruiting workers for actual operations but also in the attempts of the collateral contractor to establish an adequate force for the accomplishment of the work required here concurrently with the construction and equipment of the new Rolled Powder Area at Radford.

Flash-reducer charges for the 155 MM Gun, M1, were specified by the Ordnance Department as the most critical item scheduled at New River, and operations on this and the other charges required of this plant were conducted in every available Explosives Building as equipment was delivered and installed. The changes necessary to accomplish the reduction which was actually achieved, particularly during the earlier months, are detailed in "Memorandum B," which is attached, and the total production by types and by months for the eleven months, from September 14, 1944, through August 24, 1945, is listed on the second page of "Memorandum C."

8. Additional Facilities Considered

The work of the collateral contractor necessary to the operations as planned in July and August of 1944 was not completed until February 18, 1945.

Change Order 36, January 19, 1945, called for a considerable increase in the capacities provided for in Change Order 29. The plans made for handling this increased capacity and the extent to which these plans were carried out are detailed on pages 327-331 of "Memorandum A" attached; they are of minor significance so far as the story of operations is concerned. The need for this additional capacity had been dissipated by the trend of the war in Europe.

9. Personnel Recruiting

The initial period of heavy employment during 1941 and early 1942 had found an adequate number of well-qualified men and women available at all times. During the time which elapsed from the peak of employment in the spring of 1942 to the inception of the rehabilitation program in the summer of 1944, the plant population had decreased to a low of approximately 350 people, and general conditions affecting the availability of manpower, which are too well known to require full discussion here, had changed to an extent which made this matter the governing factor in all subsequent planning. The progress made in the solution of this problem can be seen in the following table which lists the number of employees at the end of each of the months indicated:

1944	June	759	
	July	989	
	August	1,299	
	September	1,711	
	October	2,277	
	November	2,534	
	December	3,206	
1945	January	4,673	
	February	5,181	
	March	5,202	
	April	5,354	
	May	5,111	(Peak of 5,505 reached May 9)
	June	3,611	
	July	1,834	
	August	468	
	September	324	

MEMORANDUM A

SUMMARY OF SUPPLEMENTS AND CHANGE ORDERS TO CONTRACT W-ORD-462

COVERING THE OPERATIONS OF NEW RIVER ORDNANCE PLANT.

Change Order 15, August 11, 1943, provided for additional facilities at New River for waterproofing trench-mortar increments and for operation of New River as a Storage Depot.

Supplement 18, January 29, 1944, among its other provisions, formalized the work described in Change Order 15.

Change Order 20, February 12, 1944, provided for the modification of existing facilities at New River to allow packaging of M2 increments for the 81 MM Mortar.

Change Order 22, March 10, 1944, provided facilities for the production of not more than 300,000 flash reducers per month at New River. The flash-reducer charge specified in this Change Order as T1- for use in conjunction with 155 MM Propelling Charge for the M1 Gun - was identified as Flash Reducer M1 after standardization of the charge had been accomplished.

Supplement 23, April 4, 1944, among its other provisions, formalized the work described in Change Orders 20 and 22.

Change Order 25, May 1, 1944, provided for special packaging of 302,000 rounds of trench-mortar increment replacement ammunition through the use of facilities which had already been made available by the provisions of Supplement 18 and Change Order 20.

Change Order 26, May 17, 1944, provided that, "that part of the construction and installation work which is identical with that previously performed under the construction program at Radford Ordnance Works and the New River Ordnance Plant" called for by Change Order 22 should be performed by a collatoral contractor.

Change Order 27, July 5, 1944, provided for the performance of all work and services (except construction and procurement of additional equipment) necessary in preparation for operation of facilities at New River for the loading of:

(a) Not more than 1,000,000 105 MM Howitzer M2, M2A1, and M4 Propelling Charges or their equivalent per month;

(b) Not more than 300,000 155 MM Howitzer M4A1 Propelling Charges or their equivalent per month.

It should be particularly noted that this change order contains the following paragraph: "A Site letter requesting approval for the necessary construction and the necessary procurement of additional production equipment is being forwarded for approval. Therefore, this Change Order is not intended, and is not to be construed to authorize any expenditure of funds in connection with said construction and said procurement of additional production equipment. Authorization for such work will follow immediately upon approval of site letter." At the same time Teletype No. 38360, dated July 4, 1944, from the Office of the Field Director of Ammunition Plants to the Commanding Officer of Radford Ordnance Works provided tentative propelling charge schedules for contemplated full production of flash reducers and initial production of 105 MM Howitzer Charges in September. Authority to proceed with construction and purchase of equipment was received only through the execution and acknowledgment of Change Order 29 on August 19, 1944, and the siz weeks' delay thus occasioned was never entirely regained.

Change Order 29, August 9, 1944, increased the requirements of Change Order 27; the new capacities are given below:

(a) 1,500,000 charges 105 MM

(b) 350,000 155 MM M4A1

(c) 300,000 Flash Reducer T1

(d) The manufacture of the necessary bags for (a), (b), and (c) above.

Supplement No. 30, August 31, 1944, among its other provisions, formalized the work described in Change Orders 25, 26, 27, and 29.

Change Order 32, November 13, 1944, provided for the procurement of three additional automatic machines for the packaging of trench-mortar increments, this in connection with work authorized by Change Order No. 15 and interim letters of

instruction.

Change Order 34, December 29, 1944, provided for the expansion of the Trench Mortar Increment Packaging Operation to a total of approximately 640,000 pounds per month of double-base powder.

Change Order 36, January 19, 1945, provided for increase in the capacity for the loading of propelling charges at New River to the following:

(a) 1,500,000 105 MM How, M2, M2A1, and M4

(b) 350,000 155 MM M4A1 (including igniter charges therefor)

(c) 350,000 155 MM M4A1 (including igniter charges therefor) or 315,000 8" Howitzer M2 (including igniter charges therefor) and

(d) 350,000 155 MM M4A1 (including igniter charges therefor)

Items (c) and (d) in this tabulation contemplated the provision of alternate facilities which could be used in the production of either of the two charges specified, and this change order specifically recognized that production at these levels would require the rehabilitation of one additional Loading Line (No. 4) beyond those on which work had already begun and the construction of one new Loading Line. Actually only one-half of Line No. 4 in which the increment packaging program (to which reference has been made above) had been carried on was over completed and put into operation on propelling charges. Work was stopped on Line No. 5 after the grading, the construction of a Canteen and Heater House, and some preparatory work on the B-Side had been accomplished.

Supplement 42, April 9, 1945, provided for the formalizing of the work called for by Change Orders 32, 34, and 36.

Change Order 45, May 10, 1945, authorized and directed the termination of all work and the cancellation of all subcontracts and purchase orders for materials, supplies, or services in connection with the construction of No. 5 Loading Line, subject to the following limitations:

(a) The A-Side of No. 5 Line to be cancelled in its entirety.

(b) The B-Side of No. 5 Line, then in process of construction, to to be completed without utilities or equipment, grounding, safety chutes, walks, and barricades. Actually, because of the shortage of manpower, and the consequent delay in the trench-mortar powder production at Radford, all work on this line was stopped, and beyond a token clean-up of the area, nothing further was done.

Change Order 46, May 12, 1945, directed the termination of all work and the cancellation of all subcontracts and purchase orders for equipment, materials, supplies, or services "which are not necessary to meet the revised production schedules issued by the office of the Field Director of Ammunition Plants..... or about 4 May 1945 for New River Ordnance Plant, except such items as may be expressly excepted by the Contracting Officer."

Change Order 49, July 7, 1945, accepted by Hercules Powder Company on August 10, superseded Change Order 49 as originally writeen, which was not entirely satisfactory to the plant. This fact accounts for the apparent discrepancy between the date of change order itself and the reference in the introductory paragraph of the change order to a teletype dated July 21. The change order provided for the production of complete fin assemblies for 10" Mortar T29, or any of its component parts, which might be scheduled by the Office of the Field Director of Ammunition Plants within the capacity of facilities already available at New River and approved any such work performed prior to the date of the change order. Actually, only two hundred complete fin assemblies were made; further work was held up because of difficulties encountered with the weapon during tests. Plans had been completed for the loading of additional propelling and igniter charges at New River for subsequent shipment to Louisiana Ordnance Plant at Shreveport, La., for complete assembly, but initial production on this basis scheduled for September, 1945, was not reached prior to the end of the Pacific war.

Change Order 51, July 13, 1945, July 13, 1945, provided for the production of

three new types of flash-reducer charges - the T2, T3, and T4, for the 155 MM Howitzer M1, the 8" Howitzer M1, and the 105 MM Howitzer M2, respectively, "in such amounts as may be directed from time to time by the Contracting Officer and as are within the capacity of the plant." Initial quantities were produced in July as scheduled; and the August production, on schedule up to the middle of the month was terminated short of completion by the end of the Pacific war.

Change Order 53, August 6, 1945, provided formal confirmation of instructions which had been given to Hercules Powder Company from time to time by the Office of the Field Director of Ammunition Plants for the manufacture of certain miscellaneous items not regularly scheduled, and ratified and approved "any such work performed prior to the date of this Change Order." It should be noted in this connection that Contract W-ORD-462, DA-W-ORD-26 as Amended, provided fees on a unit basis, and carried with it authority only for the performance of such work as was specifically set out in the change orders and supplements to it. This type of contract was unique among the four plants which made up the Propellant Loading Industry, the other three - Hoosier, Coosa River, and Mississippi - all being similar in form to W-ORD-492. This difference caused considerable confusion in the relations between the Loading Group, the Powder and Explosives Group, and the Legal Section in the Office of the Field Director, and as a result it was necessary for plant management at New River to scrutinize all instructions received for work at this plant with the utmost care.

MEMORANDUM "B"

SMOKELESS LOADING LINE NUMBER 1

"A" SIDE

November 5, 1944, to December 31, 1944

Line cleaned on 8-to-4 shift on November 5, 1944.
Production of flash reducer started on 8-to-4 shift November 5, 1944.
Production of flash reducer stopped on 12-to-8 shift December 31, 1944.
Production shifted to Line 3-A.

January 1, 1945, to January 9, 1945

Mason and Hanger doing construction work: getting line ready for 155 MM How., M4A1 Operations.

January 9, 1945, to June 3, 1945

Line cleaned on 4-to-12 shift on January 9, 1945.
Production of 155 MM How., M4A1 started on 12-to-8 shift January 9, 1945.
Production on 155 MM How., M4A1 stopped on 12-to-8 shift on June 3, 1945.
Production shifted to Line 4-A.

June 3, 1945, to June 27, 1945

Line cleaned on 8-to-4 shift June 3, 1945, and turned over to Maintenance Department for repairs.

June 27, 1945, to August 25, 1945

Line cleaned on 12-to-8 shift on June 27, 1945.
Production of 155 MM How., M4A1 started on 8-to-4 shift June 28, 1945.
Production on 155 MM How., M4A1 stopped on 8-to-4 shift on August 24, 1945.
Hourly operators terminated on 8-to-4 shift August 25, 1945, according to shutdown procedure.

"B" SIDE

September 25, 1944, to November 5, 1944

Line cleaned on 4-to-12 shift on September 25, 1944.
Production of flash reducer started on 12-to-8 shift September 25, 1944.
Production of flash reducer stopped on 12-to-8 shift November 4, 1944.
Production shifted to Line 1-A.

November 5, 1944, to December 17, 1944

Mason and Hanger doing construction work: getting line ready for 155 MM How., M4A1 Operations.

December 17, 1944, to June 28, 1945

Line cleaned on 4-to-12 shift on December 17, 1944.
Production of 155 MM How., M4A1 started on 12-to-8 shift December 17, 1944.
Production on 155 MM How., M4A1 stopped on 12-to-8 shift June 27, 1945.
Production shifted to Line 1-A.

June 28, 1945, to July 16, 1945

Line cleaned on 8-to-4 shift June 28, 1945, and turned over to Maintenance Department for repairs.

July 16, 1945,to August 25, 1945

Line cleaned on 8-to-4 shift on July 16, 1945.
Production of 155 MM How., M4A1 started on 8-to-4 shift July 16, 1945.
Production on 155 MM How., M4A1 stopped on 8-to-4 shift August 24, 1945.
Hourly operators terminated on 8-to-4 shift August 25, 1945, according to shutdown procedure.

SMOKELESS LOADING LINE NUMBER II

"A" SIDE

December 19, 1944, to December 23, 1944

Line cleaned on 8-to-4 shift on December 19, 1944.
Training class of colored operators for 105 MM How., M2, M2A1 started on 4-to-12 shift on December 19, 1944.
Wheat used during training period.

December 23, 1944,to August 18, 1945

Line cleaned of wheat on 8-to-4 shift December 23, 1944.
Production of 105 MM How., M2, M2A1 started on 8-to-4 shift December 23, 1944
Production on 105 MM How., M2, M2A1 stopped on 8-to-4 shift August 15, 1945.
Hourly operators terminated on 8-to-4 shift August 18, 1945, according to shutdown procedure.

"B" SIDE

January 4, 1945, to August 18, 1945

Line cleaned on 4-to-12 shift January 4, 1945.
Production of 105 MM How., M2, M2A1 started on 8-to-4 shift, January 5, 1945
Production stopped on 8-to-4 shift on August 15, 1945.
Hourly operators terminated on 8-to-4 shift on August 18, 1945, according to shutdown procedure.

SMOKELESS LOADING LINE NUMBER III

"A" SIDE

August 29, 1944, to September 14, 1944.

Mason and Hanger doing construction work: getting line ready for single operation on 105 MM How., M2, M2A1.

September 14, 1944, to December 16, 1944

Line cleaned on 8-to-4 shift September 14, 1944.
Production of 105 MM How., M2, M2A1 started on 8-to-4 shift September 14, 1944
Production stopped on 12-to-8 shift December 15, 1944.
Production shifted to Line 2-A.

December 16, 1944,to December 31, 1944

No production.
White operators used to train colored operators on Line 2-A.

December 31, 1944, to January 20, 1945
Production on flash reducer started December 31, 1945.
Production on flash reducer stopped January 19, 1945.
Production shifted to new Flash Reducer House.

January 20, 1945, to February 18, 1945
Mason and Hanger during construction for two-way operation for 105 MM How., M2, M2A1.

February 18, 1945, to August 18, 1945
Line cleaned on 12-to-8 shift on February 18, 1945.
Production started on 12-to-8 shift February 18, 1945.
Production stopped on 8-to-4 shift August 17, 1945.
Hourly operators terminated on the 8-to-4 shift August 18, 1945, according to shutdown procedure.

"B" SIDE

September 5, 1944, to September 18, 1944
Mason and Hanger doing construction work: getting line ready for single operation on 105 MM How., M2, M2A1.

September 18, 1944, to November 19, 1944
Line cleaned on 8-to-4 shift September 18, 1944.
Production of 105 MM How., M2, M2A1 started on 8-to-4 shift September 18, 19[illegible]
Production of 105 MM How., M2, M2A1 stopped on 8-to-4 shift November 18, 19[illegible]

November 19, 1944, to November 21, 1944
Mason and Hanger doing construction work: getting line ready for temporary operations on 155 MM How., M4A1.

November 21, 1944, to December 17, 1944
Line cleaned on 8-to-4 shift November 21, 1944.
Production of 155 MM How., M4A1 started on 8-to-4 shift November 21, 1944.
Production of 155 MM How., M4A1 stopped on 4-to-12 shift December 16, 1944.
Production shifted to Line 1-B.

December 18, 1944, to January 21, 1945
Line cleaned of powder and inspected, then turned over to Mason and Hanger for construction work: getting line ready for two-way operation on 105 MM How., M2, M2A1.

January 21, 1945, to August 18, 1945
Line cleaned on 12-to-8 shift January 21, 1945.
Production of 105 MM How., M2, M2A1 started on 8-to-4 shift January 22, 1945.
Production of 105 MM How., M2, M2A1 stopped on 8-to-4 shift August 17, 1945.
Hourly operators terminated on the 8-to-4 shift August 18, 1945, according to shutdown procedure.

SMOKELESS LOADING LINE NUMBER IV

"A" SIDE

November 16, 1943, to December 7, 1943

Dethreading of rolled powder, rejected increments from R.O.W. started Novembe 16, 1943, because of shortage of cellophane bags.

December 7, 1943, to March 11, 1945

Production of cellophane bagging of rolled powder started on 8-to-4 shift December 7, 1943.
Production of cellophane bagging of rolled powder stopped on 4-to-12 shift March 10, 1945.
Cellophane bagging of rolled powder shifted to Igniter Line No. 2.
Rolled Powder Salvage Operation shifted to R.O.W.

March 11, 1945, to May 10, 1945

Mason and Hanger doing construction for 155 MM How., M4A1 Operation.

May 10, 1945, to May 13, 1945

Line cleaned on 8-to-4 shift on May 11, 1945.
Production of 10" Mortar started on 8-to-4 shift May 12, 1945.
Production of 10" Mortar stopped on 4-to-12 shift May 12, 1945.
Only pilot lot loaded.

May 13, 1945, to June 3, 1945

No production - Line not needed because of shortage of labor at this time.

June 3, 1945, to June 29, 1945

Line cleaned on 12-to-8 shift June 3, 1945.
Production of 155 MM How., M4A1 started on 12-to-8 shift June 3, 1945.
Production of 155 MM How., M4A1 stopped on 12-to-8 shift June 28, 1945.
Production shifted back to Line 1-A since repair work on Line 1-A had been completed.

June 29, 1945, to July 16, 1945

No production - Line not needed because of present schedule.

July 16, 1945, to August 11, 1945

Line cleaned on 8-to-4 shift on June 15, 1945.
Production of 105 MM How., M2, M2A1 started on 8-to-4 shift July 16, 1945.
Production of 105 MM How., M2, M2A1 stopped on 8-to-4 shift August 10, 1945.
The crew on this line was used to bring crews on other lines to full strength

"B" SIDE

November 3, 1943, to November 8, 1943

Line cleaned on 8-to-4 shift November 3, 1943.
Training class started on 8-to-4 shift November 3, 1943, packing of rolled-powder increments for trench mortar.
Using increments made of paper during training.

November 8, 1943, to November 13, 1943

Dethreading of rejected increments from R.O.W. started on 8-to-4 shift, November 8, 1943, because of shortage of cellophane bags.

November 13, 1943, to August 18, 1945

Production of cellophane bagging of rolled-powder increments started on 8-to-4 shift November 13, 1943.
Production of cellophane bagging of rolled-powder increments stopped on 8-to-4 shift August 18, 1945.
Hourly operators terminated on the 8-to-4 shift August 18, 1945, according to shutdown procedure.

IGNITER LINES

LINE NO. 1

June 1, 1944, to June 8, 1944

Line cleaned and set up for production of pilots lots of flash reducer on temporary basis before the installation of piping and other equipment.
Production shifted to Igniter Line No. 2.

June 8, 1944, to June 21, 1944

Line turned over to Maintenance Department for installation of equipment for flash-reducer loading.

June 21, 1944, to February 21, 1945

Line cleaned on 8-to-4 shift on June 21, 1944.
Production of flash reducer started on 8-to-4 shift June 21, 1944.
Production of flash reducer stopped on 12-to-8 shift February 20, 1945.
Line turned over to Mason and Hanger.

February 21, 1945, to March 4, 1945

Line turned over to Mason and Hanger for construction and installation of equipment for igniter loading.

March 4, 1945, to August 1, 1945

Line cleaned on 12-to-8 shift March 4, 1945.
Production of igniters for 155 MM How., M4A1 started on 8-to-4 shift March 5, 1945.
Production of igniters for 155 MM How., M4A1 stopped on 8-to-4 shift July 31, 1945.
Production shifted to Igniter Line No. 2.

August 1, 1945, to August 16, 1945

No production - because of reduction in schedule.

LINE NO. 2

May 22, 1944, to May 26, 1944

Line cleaned on 8-to-4 shift May 22, 1944.
Production of first pilot lot of flash reducer started on 8-to-4 shift May 22, 1944.
Production of flash-reducer pilot lots stopped on 8-to-4 shift May 25, 1944.
Production shifted to Igniter Line No. 1.

May 26, 1944, to June 9, 1944

Line turned over to Maintenance Department for installation of equipment for flash-reducer loading.

June 9, 1944, to June 20, 1944

Line cleaned on 8-to-4 shift June 9, 1944.
Production of flash-reducer pilot lot started on 8-to-4 shift June 9, 1944.
Production of flash-reducer pilot lot stopped on 8-to-4 shift June 19, 1944.

June 20, 1944, to November 13, 1944

Line cleaned and set for regular production on 8-to-4 shift June 20, 1944.
Production of flash reducer started on 8-to-4 shift June 20, 1944.
Production of flash reducer on half of line stopped on 8-to-4 shift November 13, 1944.
Production of one-half of line changed to igniter loading.

November 13, 1944, to March 6, 1945

Production of flash reducer continued on half the line.
One-half of line cleaned and set for igniter loading on 8-to-4 shift.
Production of igniter for 155 MM How., M4A1 started on 8-to-4 shift November 13, 1944.
Production of igniter for 155 MM How., M4A1 stopped on 8-to-4 shift March 5, 1945.
Production shifted to Igniter Line No. 1.

March 6, 1945, to March 12, 1945

Line turned over to Mason and Hanger for installation of equipment for packing rolled-powder increments.

March 12 , 1945, to May 27, 1945

Line cleaned on 8-to-4 shift on March 12, 1945.
Production of packing of rolled powder started on 8-to-4 shift March 12, 194
Production of packing of rolled powder stopped on 8-to-4 shift March 26, 194
Production shifted to R.O.W.

May 27, 1945, to June 1, 1945

Line turned over to Mason and Hanger to complete construction and installati of equipment for igniter loading.

June 1, 1945, to August 1, 1945

No production because of reduction in schedule.

August 1, 1945, to August 16, 1945

Line cleaned on 8-to-4 shift August 1, 1945. Production of 155 MM How., M4A1 started on 8-to-4 shift August 1, 1945. Production of 155 MM How., M4A1 stopped on 8-to-4 shift August 15, 1945.
Hourly operators terminated on 8-to-4 shift August 17, 1945, according to shutdown procedure.

LINE #1

"A"	"B"
11-5-44/12-31-44 Flash Reducer	9-25-44/11-5-44 Flash Reducer
1-1-45/1-9-45 Contractor	11-5-44/12-17-44 Contractor
1-9-45/6-3-45 155 How.	12-17-44/6-28-45 155 How.
6-3-45/6-27-45 Maintenance	6-28-45/7-16-45 Maintenance
6-27-45/8-25-45 155 How.	7-16-45/8-25-45 155 How.
8-25-45 Ceased Production	8-25-45 Ceased Production

LINE #2

"A"	"B"
12-19-44/12-23-44 Training	1-4-45/8-18-45 105 How.
12-23-44/8-18-45 105 How.	8-18-45 Ceased Production
8-18-45 Ceased Production	

LINE #3

8-29-44/9-14-44 Contractor	9-5-44/9-18-44 Contractor
9-14-44/12-16-44 105 How.	9-18-44/11-19-44 105 How.
12-16-44/12-31-44 Shut down	11-19-44/11-21-44 Contractor
12-31-44/1-20-45 Flash Reducer	11-21-44/12-17-44 155 How.
1-20-45/2-18-45 Contractor	12-17-44/1-21-45 Contractor
2-18-45/8-18-45 105 How.	1-21-45/8-18-45 105 How.
8-18-45 Ceased Production	8-18-45 Ceased Production

LINE #4

11-16-43/12-7-43 Deth.Rolled Powder	11-3-43/11-8-43 Rolled Powder Training
12-7-43/3-11-45 Pack.Rolled Powder	11-8-43/11-13-43 Deth.Rolled Powder
3-11-45/5-10-45 Contractor	11-13-43/8-18-45 Pack.Rolled Powder
5-10-45/5-13-45 10" Mortar	8-18-45 Ceased Production
5-13-45/6-3-45 Shut down	
6-3-45/6-29-45 155 How.	
6-29-45/7-16-45 155 How.	
7-16-45/8-11-45 105 How.	
8-11-45 Shut down	

IGNITER LINES

Igniter #1

6-1-44/6-8-44
Pilot Lots Flash Reducer

6-8-44/6-21-44
Maintenance

6-21-44/2-21-45
Flash Reducer

2-21-45/3-4-45
Contractor

3-4-45/8-1-45
Igniters

8-1-45 Shutdown

Igniter #2

5-22-44/5-26-44
Pilot Lots Flash Reducer

5-26-44/6-9-44
Maintenance

6-9-44/6-20-44
Pilot Lots Flash Reducer

6-20-44/11-13-44
Flash Reducer

11-13-44/3-6-45
½ Flash Reducer
½ Igniters

3-6-45/3-12-45
Contractor

3-12-45/5-27-45
Pack. Rolled Powder

5-27-45/6-1-45
Contractor

6-1-45/8-1-45
Shutdown

8-1-45/8-16-45
Igniters

8-16-45 Ceased
Production

FLASH REDUCER HOUSES

	House #1	House #2	House #3	House #4	House #5	House #6	House #7	House #8
Flash Reducer M1 Production Started:	11-20-44	11-26-44	12-6-44	12-31-44	1-8-45	1-18-45	1-29-45	2-7-45
Flash Reducer M1 Production Stopped:	8-15-45	8-15-45		8-15-45	8-15-45	8-15-45	8-15-45	7-20-45
Flash Reducer T2 Production Started:								7-21-45
Flash Reducer T2 Production Stopped:								7-24-45
Flash Reducer T3 Production Started:								7-24-45
Flash Reducer T3 Production Stopped:								7-27-45
Flash Reducer T4 Production Started:								7-27-45
Flash Reducer T4 Production Stopped:								8-1-45
Flash Reducer T2 Production Started:								8-1-45
Flash Reducer T2 Production Stopped:								8-8-45
Flash Reducer T3 Production Started:								8-8-45
Flash Reducer T3 Production Stopped:								8-15-45
Hourly Operators Terminated According to Shutdown Procedure as Follows:	8-17-45	8-17-45	8-17-45	8-17-45	8-17-45	8-17-45	8-17-45	8-17-45

FLASH REDUCER HOUSES

House #1	House #2	House #3	House #4	House #5	House #6	House #7	House #8
11-20-44 8-15-45 M-1 Flash Reducer	11-26-44 8-15-45 M-1 Flash Reducer	12-6-44 8-15-45 M-1 Flash Reducer	12-31-44 8-15-45 M-1 Flash Reducer	1-8-45 8-15-45 M-1 Flash Reducer	1-18-45 8-15-45 M-1 Flash Reducer	1-29-45 8-15-45 M-1 Flash Reducer	2-7-45 7-21-45 M-1 Flash Reducer 7-21-45 7-24-45 T-2 Flash Reducer 7-24-45 7-27-45 T-3 Flash Reducer 7-27-45 8-1-45 T-4 Flash Reducer 8-1-45 8-8-45 T-2 Flash Reducer 8-8-45 8-15-45 T-3 Flash Reducer

MEMORANDUM "C"

SUMMARY OF PRODUCTION
NEW RIVER ORDNANCE PLANT, RADFORD, VIRGINIA
September 21, 1941 Thru August 24, 1945

CONTRACT W-ORD-492
Production (9/21/41 Thru 5/24/43)
(Bag Loading)

TYPE CHARGE	CHARGES PRODUCED
105 MM How., M2	6,684,093
105 MM How., M2, H.E.A.T.	287,848
105 MM How., M3	303,079
105 MM How., M3, H.E.A.T.	91,685
155 MM How., M2 (W.B.)	1,146,360
155 MM How., M3 (G.B.)	1,582,553
155 MM Gun, M1	981,514
8" How., M1 (G.B.)	120,560
8" How., M2 (W.B.)	16,106
8" Gun, MK VI	17,001
10" Gun	3,271
12" Gun	4,820
4.7" A.A. Gun, Ig. Assembly	72,100
Test Loading	1,104
TOTAL	11,312,094

CONTRACT W-ORD-462
Production (11/13/43 Thru 8/24/45)

Rolled Powder Packaged Increments

No. Lbs. Loaded	No. Increments Packaged
3,373,089 Lbs.	239,709,029 Ea.

Production 5/18/44 Thru 8/31/44)
(Bag Loading)

TYPE CHARGE		CHARGES PRODUCED
Flash Reducer T1 (M1) For 155 Gun	TOTAL	84,993

Production (9/1/44 Thru 8/24/45)

105 MM How., M2		6,050,016
155 MM How., M4A1		1,945,982
Flash Reducer, M1 (T1) for 155 Gun		2,288,498
Flash Reducer, T2 for 155 How.		90,800
Flash Reducer, T3 for 8" How.		42,450
Flash Reducer, T4 for 105 How.		21,000
Fin Assembly for 10" Mortar T-29		200
	TOTAL	10,438,946

Total Chgs. Loaded	* 21,836,033
Total Lbs. Loaded	*122,220,161

*Does not include Rolled Powder

MONTHLY PRODUCTION
September, 1944 Thru August 24, 1945
NEW RIVER ORDNANCE PLANT, RADFORD, VIRGINIA

Year	Month	105 MM. How. M2 & M2A1 No. Chgs.	155 MM. How., M4A1 No. Chgs.	Flash Reducer M1 (T1) No. Chgs.	Flash Reducer T-2 No. Chgs.	Flash Reducer T-3 No. Chgs.	Flash Reducer T-4 No. Chgs.	10" Mortar Fin. Assembly No. Chgs.	Smokeless Powder Lbs.	Black Powder Lbs.	Rolled Powder & Potassium Sulphate Lbs.	Total Lbs.
1944	September	46,120		50,340					132,624	49,581	163,964	346,169
1944	October	201,200		118,050					578,576	106,245	230,285	915,106
1944	November	203,600	8,463	153,491					699,410	139,729	342,680	1,181,819
1944	December	52,360	60,387	174,000					963,528	167,923	280,172	1,411,623
1945	January	302,616	177,179	304,627					3,255,482	309,171	462,074	4,026,727
1945	February	324,416	195,181	314,800					3,560,523	319,916	465,487	4,345,926
1945	March	749,440	296,483	319,300					6,146,511	342,960	550,537	7,040,008
1945	April	897,560	336,950	333,350					7,343,349	363,493	529,921	8,236,763
1945	May	1,264,680	327,500	228,330				200	7,995,684	266,903	450,726	8,713,313
1945	June	1,283,160	300,000	140,040					7,662,786	182,286	393,788	8,238,860
1945	July	550,324	155,672	92,790	10,000	7,500	20,000		3,664,815	116,200	313,719	4,094,734
1945	August	174,540	88,167	59,380	80,800	34,950	1,000		1,682,662	65,273	111,812	1,859,747
	TOTAL	6,050,016	1,945,982	2,288,498	90,800	42,450	21,000	200	43,685,950	2,429,680	4,295,165	50,410,795
								Total - Pounds Loaded Nov. 1943 Thru August, 1944	- 0 -	75,936	594,705	670,641
								Total - Pounds Loaded Sept. 24, 1941 Thru May, 1943	73,294,548	1,217,266	- 0 -	74,511,814
								Grand Total - Pounds Loaded (Both Operations)	116,980,498	3,722,882	4,889,870	125,593,250

Chapter XVIII

ENGINEERING DEPARTMENT

A. Introduction

1. Responsibilities

The Engineering Department was held responsible to the management for the proper accomplishment of the following:

a. Repair and maintenance of all mechanical equipment except sewing machines and scales.
b. Repair and maintenance of Electric lines and electrical equipment.
c. Supervision of water, heat, and sewage facilities to buildings and the operation and maintenance of attendant equipment.
d. Operation and maintenance of railroad facilities within the plant.
e. Upkeep and maintenance of grounds, roads, and railroads.
f. Preparation of drawings for new work; keeping all drawings "as built"; reproduction of drawings; and operation of the photostat equipment.

2. Organization

The proposed Organization Chart shown on page 345 was prepared in Wilmington in June, 1941, before the Operating Department had moved down to the plant site. With the start-up of operations in September, 1941, actual organization of the department was started, expanding the original chart in the manner indicated on the Organization Chart on page 346. Organization was completed during February, 1942. Men to fill the key positions were transferred from Hercules Construction Forces or taken over from Mason and Hanger as their services were required, or as their services could be spared from their duties in the construction of the plant.

The Engineering Department operated essentially as shown on the chart on page 346 until operations were terminated in May, 1943, except for a short period in 1943, July through September, when the Scale and Sewing Machine departments were placed under the master mechanic.

B. Activities - Original Contract

1. Construction Period

It is quite difficult at times to differentiate between the work done by Construction during the building of the plant, which work has been outlined in another chapter, and the work done by the Engineering department proper for operation. However, the main activities in the Engineering Department as such may be listed as follows:

a. Maintenance and repair of all gasoline- and Diesel-powered equipment which had been turned over to the Operating departments.
b. Checking on the installation line shafts and other general equipment to familiarize maintenance personnel with installation.
c. Operating intra-plant railroads and handling construction materials as well as explosives and inert materials required for operation.

2. Initial Period of Operations

a. Completion of Work for Mason and Hanger

During the latter part of 1941, the construction of New River Ordnance Plant was initially completed and the plant put into operation, there being certain items of equipment on which delivery could not be made for a period up to six months. With the above in mind, steps were taken to terminate the Mason and Hanger Construction Contract and turn over the work necessary for the completion of the plant to Hercules Powder Company Maintenance Forces. Negotiations were completed and Mason and Hanger's Contract was terminated as of January 31, 1942. In turning over the completing of the plant to Hercules, the area engineer authorized the payment of materials and supplies then on order to complete the items of work stated. The estimated cost of work to complete the plant was approximately $80,000. The main items of work for the completion of the plant was as follows:

(1) Complete surfacing of road to River Pumping Station.
(2) Install unit heaters as shown on approved plans.
(3) Install an induced-draft fan in main Boiler House.
(4) Complete installation of equipment at Gasoline Service Station and Oil Storage.
(5) Complete electrical work in Bag Loading buildings.
(6) Build dry walls in certain Igloo head walls and install French storage extension for certain Igloos.
(7) Complete landscaping and planting for entire plant.

(8) Install surge surpressor at River Pump Station and telemeter at Filter Plant.
(9) Install lighting on boom at River Pump House and complete installation of light fixtures on fence lightings.
(10) Complete Electric Power System. (Complete sub-station, remove temporary pole lines, reset transformers, etc.)
(11) Complete installation of radios and radio transmitters.

Work on the above items was completed during June, 1942.

a. Completion Report

During the early part of 1942, the majority of the Office Force of the Engineering Department devoted practically all of their time to the Completion Report. During this time all drawings for the plant were revised to "as built." All drawings were referenced and several maps of the entire area were prepared. When the Completion Report was finished, it was submitted for approval by higher authorities on May 19, 1942. On June 2, 1942, the area engineer notified New River that the Completion Report had been accepted and that Hercules Powder Company was released from all work under this portion of the contract.

3. Projects

a. Plant Improvement

Soon after operations started it was apparent that changes would have to be made in existing buildings and new buildings provided in order to obtain maximum economy in the operation of the plant. The work was done by Plant Maintenance Forces. The major items of work were as follows:

(1) Provide additional office and shop space in the Combined Shops.
(2) Move existing Electrical Shop from outside of Guarded Area to new location inside Guarded Area.
(3) Provide Office Building with canteen facilities and an additional building for storage of heavy equipment for outside maintenance crew.
(4) Provide Tractor Shed in Shop Area for working on tractors and painting automotive equipment.
(5) Provide toilet facilities in the Warehouse Area for use of the employees.
(6) Provide Inert Warehouse on Loading lines for storage of working stocks of inert materials.
(7) Purchase and install capacitors to correct power factors.

During the original construction of the main Boiler House, it was necessary to take boilers slightly smaller than those specified in order to get the plant in operation on schedule. Soon after operations started, since it was evident that the two boilers provided coult not adequately furnish sufficient steam under all conditions for proper operations, a project was prepared and approved for the installation of an additional boiler. This work was completed in the fall of 1942.

Since recreation facilities in the area were limited, the commanding officer authorized the following work to be done to provide additional facilities:

(1) Grade area and provide back-stops for 1 hard- and 2 soft-ball fields.
(2) Construct two tennis courts.
(3) Design and construct a Bath House in vicinity of ball fields and tennis courts.
(4) Remodel Construction Building on west side of Route 100 (Mason & Hanger's old Employment Office) as a Recreation Center.

As a result of the changes of the various methods of export shipment of charges, the department was required to design and construct buildings for crating charges for overseas shipment. Design of buildings was completed and construction started when curtailment of the general ammunition program stopped work on this project.

b. Magazines for Radford

Early in 1942, it was necessary to construct additional Magazines for Radford Ordnance Works in order to handle adequately their output. Because of known and proposed increases in contemplated facilities at Radford and the shortage of space, it was decided that the additional Magazines for Radford be constructed on available land at the New River Plant.

The work on construction of the Magazines was to be under the direct supervision of Mr. H. E. Carlin, project engineer, at the Radford Plant, with the New River Maintenance Forces doing the following work:

(1) Build temporary access road from Route 11 to the Magazine Area.
(2) Build temporary access road from the Dublin Cut-off to the Magazine Area.
(3) Construct temporary fence to fence off Construction Area from Operating Area.
(4) Make all preliminary surveys and stake out all work.
(5) Make a final survey and perform all other necessary engineering work.
(6) Provide necessary temporary Storage buildings.
(7) Build the fifty-ninth Magazine.

Work on this project was started in the summer of 1942 and completed during the early part of 1943.

4. Maintenance Operations

The functions and operations in the Engineering Department for maintenance work as shown on table on page 361 were essentially as follows:

a. Mechanical Maintenance

This division was under the direct supervision of the maintenance engineer, who was responsible to the plant engineer for the maintenance and repair of all mechanical equipment except scales and sewing machines and for any new construction to be done on the plant.

The Maintenance Engineer's Organization was broken down into the following sub-divisions:

(1) Motive Equipment

This sub-division was under the supervision of the motive supervisor and was responsible to the maintenance engineer for the repair and maintenance of all motive equipment on the plant. This sub-division also operated the Service Station. In addition to regular maintenance work on equipment, each piece of equipment was inspected once a month to check its condition.

(2) Metal Shops

This sub-division was under the supervision of the metal shops supervisor, who in turn was responsible to the maintenance engineer for all work that was required. Shops coming under this jurisdiction included Tin Shops, Machine Shops, Welding Shops, and Blacksmith Shops.

(3) Carpenter Shops

This sub-division was in charge of the carpenter supervisor, who in turn was directly responsible to the maintenance engineer for all carpenter work, painting, and construction as was found necessary. During the early stages of operations, this group was further broken into an outside maintenance and construction group and an inside maintenance group. Each group was in charge of competent foremen or work leaders.

(4) Plumbing and Piping

This sub-division was in charge of the plumbing and piping supervisor, who in turn was directly responsible to the maintenance engineer to do all plumbing and piping work throughout the plant. When necessary this sub-division assisted the water and sewer division in repairing breaks in Water and Sewer lines.

(5) Line Maintenance

This sub-division was in charge of a line maintenance supervisor, who was directly responsible to the maintenance engineer for the maintenance of all production and mechanical equipment (except scales and sewing machines) in the Loading lines and in the Bag Manufacturing buildings.

All of the above sub-divisions were set up to provide service as required on the daylight shifts only, except the Service Station and Line Maintenance, which were set up for 24-hour operations.

Major machine tools in this division of the department included:

Auto Shop

1 - 10" Utility Grinder
1 - Werdenhoff Model 701 Armature Tester
1 - Cat. No. 620 Sioux Valve Face Grinder
1 - Champion Spark Plug Tester
1 - Model B51 Barret Brake Reliner
1 - Type F-160 Allen-Unitron Rectifier
2 - Model 6RB6B1 G. E. Tungar Battery Charger
1 - Lincoln Airline Lubrigun System

Pipe Shop

1 - Beaver Model B Threading Machine
1 - Oster Model 304 Threading Machine

Blacksmith Shop

1 - Lincoln Shield-Arc Welder - 250 Amps.
2 - Airco Autylene Welding and Cutting Sets
1 - Forge

Machine Shop

1 - Canedy-Otto Floor Model Drill Press - Size 1/2"
1 - Wells Power Cut Off Saw - Cap, 10"
1 - Oster Bolt Threading Machine - Cap. 1-1/2"
1 - Radial Drill - Cap. 36". Manufactured by W. E. Gang Co., Cincinnati, Ohio
1 - Atlas Arbor Press - 2 Ton
1 - Becker-Brainard Milling Machine - No. 3
1 - Gould-Eberhardt Shaper - 20"
1 - Yates-American Grinding Machine
1 - Delta Floor Model Drill Press - Size 1/2"
1 - Thor Bench Grinder - 6"
1 - Southbend Lathe - 16" x 10'

Carpenter Shop

1 - Yates-American Mortising Machine - M 40, 3. H. P.
1 - Delta Wood Turning Lathe - Cap. 48"
1 - Yates-American Jig Saw - Cap. 24"
1 - Yates-American Variable Speed Drill Press for Woodworking - Check Size 1/2"
1 - Planer - Cap. 20". Manufactured by American Sawmill Co.
1 - Yates-American Jointer - Cap. 6"
1 - Oliver Combination Saw - No. 260, Ripping Cap. 26"
1 - Oliver Disc and Belt Sander, Disc 15" and Sander 6"
1 - Utility Bench Grinder - 6"
1 - Monarch Band Saw - 30"

Sheet Metal Shop

1 - Break - Cap. 8'
1 - Pexto Roller - Cap. 36"
1 - Pexto Shearing Machine - Cap. 50"
1 - Pexto Rotary Shear - Cap. 18"
1 - Pexto Edging Machine - 2-1/2" Dies
1 - Pexto Edging Machine - 1-1/2" Dies
1 - Pexto Crimping Machine

b. Electrical Maintenance

This division was under the direct supervision of the electrical engineer, who in turn was responsible to the plant engineer for the maintenance, repair, and installation of all of the electrical equipment and lines in the plant. The Electrical Division was further broken down as follows:

(1) Outside Electrical Maintenance

This sub-division was in charge of the assistant electrical supervisor who was directly responsible to the electrical engineer for the maintenance of all high voltage and transformers (33,000 and 2400 volts).

(2) Inside Electrical Maintenance

This sub-division was in charge of the assistant electrical supervisor, who was directly responsible to the electrical engineer for the maintenance and repair for all electrical equipment within the buildings. In addition, all work on radio equipment was performed by this sub-division.

The Outside Maintenance Division was set up for operation on a 24-hour operation. The Inside Maintenance Division was set up to render service in Operating buildings when such buildings were in operation.

The following major equipment was furnished by the company:

1 - Beaver Model B Pipe Threading Machine
1 - Delta Bench Drill Press - 1/2" Capacity
1 - Delta Bench Grinder 6" Wheels Capacity
1 - Rubber Gloves, Blankets, etc., Required for Working on High-tension Lines
2 - G. E. Model 8AK1AAA1, Voltmeter-ammeter, Type AK-1
1 - Line Truck with Safety Belts and Clean Bus
1 - 3/4-ton Truck Equipment with Ladder for Charging Fence Lights
1 - Radio Test Panel consisting of:
    1 Hickock Model 188X Signal Generator
    1 Hickock Model 510 Mutual Conductance
    1 Simpson Model 284 DC Microammeter
1 - G. E. Model 8CFAA 1 Recording Ammeter, Type CF-1
1 - G. E. Model 8CF$_1$VBD1 Recording Voltmeter
1 - J. Biddle Ground Tester - 0-300 Ohms
1 - J. Biddle Megger 0-60 Megohms
1 - J. Biddle Insulation Tester
1 - Charging Rack for Edison Batteries
1 - Westinghouse Testing Outfit - KVA 0 to 0.5 to 30,000 Volts

c. Utilities

This division was under the direct supervision of the utilities engineer, who in turn was directly responsible to the plant engineer for water, heat, water filtration, sewage, Sewage Disposal Plant, and outside Water and Sewage lines of the entire plant. For convenience of operations, this division was further sub-divided into the following groups:

(1) Heating

This sub-division was in charge of the heating supervisor, who was directly responsible to the utilities engineer for the Heating System throughout the plant including boilers as well as electrical equipment directly required for the proper operation of the boilers. This division also delivered coal and oil to the boilers as required, "removed ashes," cleaned boilers, when necessary; and prepared monthly fuel reports, both for fuel oil and coal.

During operations two men were stationed in the main Boiler House to operate the two 200-horse-power fire-tube boilers or the one 420-horse-power water-tube boiler, depending upon the load. During the heating season, one man per shift was used to operate the 7 oil-burning Boiler Houses in the Explosives Area, and an additional man was employed in the operation of the 9 coal-burning boilers in the Inert areas. Delivery of coal and oil and removal of ashes and maintenance as required was performed on the daylight shift by additional members of the department.

(2) Water and Sewage

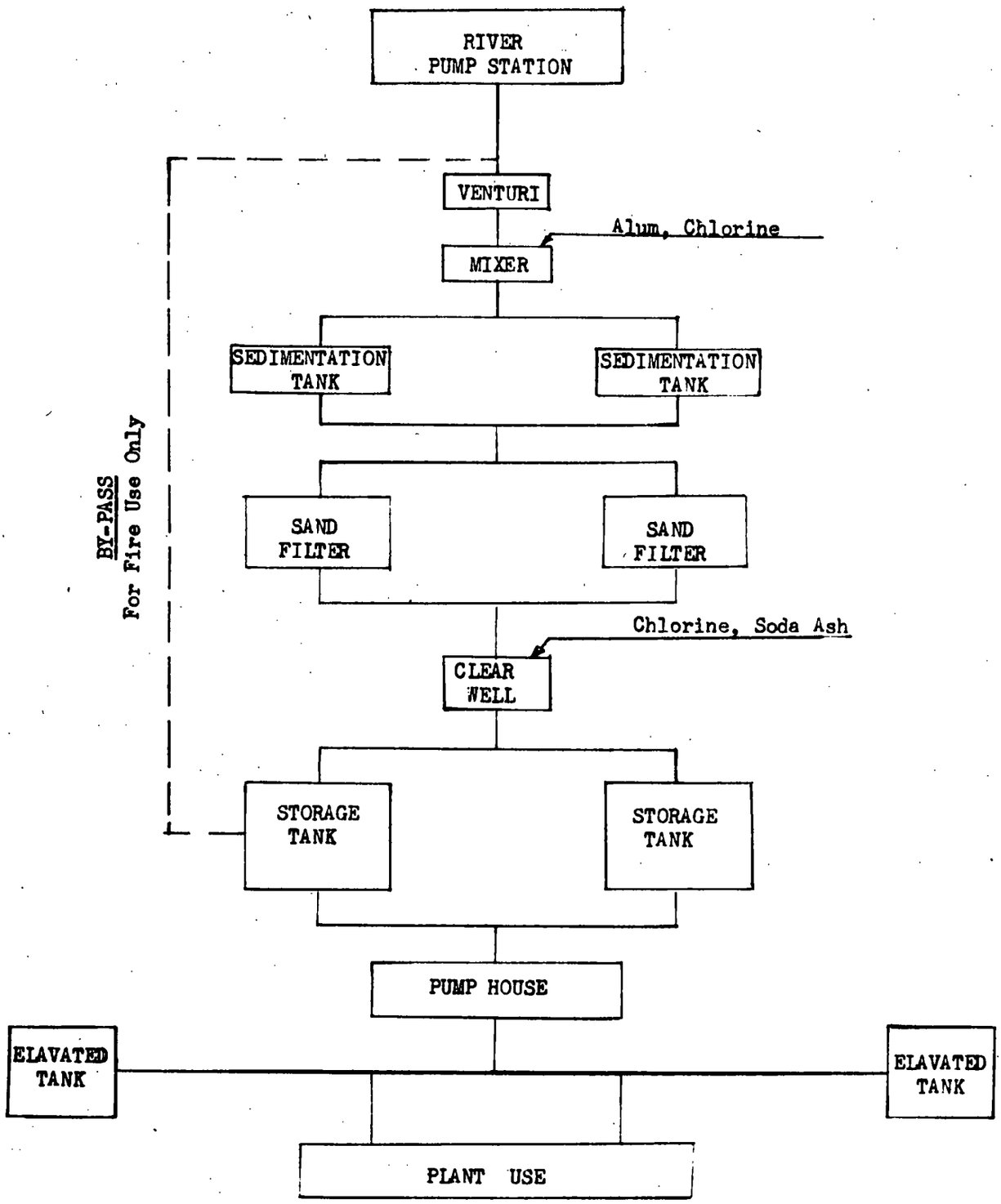
This division was in charge of the water and sewage disposal supervisor, who was directly responsible to the utilities engineer for the operation of the Water and Sewage plants and the repair and maintenance of all outside Water and Sewage lines.

(See the Schematic Flow Sheet of the plant Water System on page 372)

Equipment at the River Pumping Station consisted of two 350-gallon-per-minute service pumps and three 1000-gallon-per-minute fire pumps, all electric-driven. Water from Claytor Lake was pumped a distance of approximately 10,000 feet at the Filter Plant. The Filter Plant consisted of two gravity-flow-type sand filters, having a capacity of 450,000 gallons-per-day. Chemicals were added to the Filter Plant to assist in coagulation, purification, and pH control. Effluent from the filters flowed by gravity into two gunite storage tanks, each having a capacity of 500,000 gallons. Water from the gunite storage tanks flowed by gravity into the suction of the pumps in the Pump House. Pumping equipment consisted of two 350-gallon-per-minute service pumps (electric-driven) and three 1000-gallon-per-minute fire pumps with dual electric-gasoline drives. Discharge from the above pumps flowed into an 18-inch line which connected the two 150,000-gallon elevated tanks in the plant. Water for plant use was taken from the 18-inch line. Since the plant was designed with a one-pipe system, water from the Fire System was also taken from the 18-inch line. Minimum water pressure on the plant was 90 lbs./sq. inch whereas the maximum was 115 lbs./sq. inch.

In the design of the plant a by-pass was provided to be used only in case of fire, by-passing the Filter Plant in its entirety. Water directly from the River Pumping Station could be pumped directly into one of the gunite storage tanks, which could be isolated and then picked up by the fire pumps in the Pump House and discharged into the 18-inch main. It was intended that the by-pass be used only in an extreme emergency since water pumped directly from Claytor Lake into the Water System could contaminate the entire system.

NEW RIVER ORDNANCE PLANT
WATER SYSTEM
FLOW SHEET



In addition to the records required for normal operations, the plant also prepared a "Monthly Report of Operation of Water Purification Plant," which was forwarded to the Virginia State Department of Health, Division of Sanitary Equipment. In addition, weekly samples of water taken from service taps throughout the plant were submitted to the Virginia State Department of Health for checking.

In the event of a break in the Water lines, men and equipment to assist in the repairing were to be drawn from the Plumbing and Pipe Shops and from the Outside Maintenance crew as required. These men, along with the men of the Water and Sewer Department, were to be used directly under the supervision of the utilities engineer during the time repairs were being made.

This division also ran tests on boiler water and advised the boiler operators as to what treatment should be made to provide a water with suitable properties for proper operation of the boilers.

A Clarigester-type Sewage Disposal System was installed. Sewage flowed by gravity or was pumped into an equalizing basin located just ahead of the clarigester. Sewage flowed by gravity into the clarigester. The effluent of the clarigester was chlorinated and flowed through a 15-inch terra-cotta pipe to be discharged into Claytor Lake at a point of approximately three miles below the intake to the River Pumping Station. The sludge from the clarigester was pumped into drying beds as required. Dry sludge was disposed of as fertilizer.

Both of the above sub-divisions were set up for 24-hour, 7-day-a-week operations.

d. Outside Maintenance

The Outside Maintenance Division was under the direct supervision of the maintenance engineer, who was held directly responsible to the plant engineer for the maintenance, repair, and construction of all railroads, roads, fences, and grounds on the entire plant.

For convenience of operations, this division was further sub-divided into the following groups:

(1) Railroads

This sub-division was in charge of the railroad supervisor, who in turn was responsible to the outside maintenance engineer for the maintenance of the railroad right-of-way and all of railroad traffic on the plant.

(2) Roads and Walks

This sub-division was under the direct supervision of the road supervisor, who in turn was directly responsible to the outside maintenance engineer for the maintenance and repair for existing roads and construction of any new roads. This sub-division also performed any survey work required on the plant site and operated all grading and road equipment.

(3) Grounds

This sub-division was under the direct supervision of the grounds supervisor, who in turn was directly responsible to the outside maintenance engineer for the landscaping, planting, mowing, and policing all grounds and the maintenance of fences of entire Plant Area.

Special equipment provided this division of the Engineering Department included the following:

2 - 65-ton G. E. Electric Locomotives
2 - Farmall Tractors with Mowing Attachments
1 - 10-T Michigan Motor Crane
1 - Model 112 Caterpillar Motor Grader
1 - D-7 Caterpillar Tractor with Bulldozer Attachment
1 - Gasoline-driven Railroad Motor Car
1 - 1500-gallon Tank Truck
1 - Asphalt Distributor Truck
1 - Tar Pot
3 - 1½-T Dump Truck, Equipped with Snow Plows
1 - 30-ton Winch Truck
1 - Ingersoll Rand Model IK Portable Air Compressor
Necessary Hand Tools, such as Shovels, Picks, Lawn Mowers, Scythes, Track Working Tools, etc.

e. Drafting Room

The Drafting Room was in charge of the chief draftsman, who in turn was responsible to the plant engineer for the preparation and correction of all drawings and proper filing of same. This division of the Engineering Department, during the early part of operations, was especially active in preparing necessary drawings and gathering information for compilation of the Completion Report. After the acceptance of the Completion Report, work was reduced considerably, and with the exception of the few drawings required for the projects and the necessary surveying and calculations in connection with the building of additional Magazines for use of the Radford Plant, there was very little work for this division.

In addition to the shop equipment listed above for each craft, transportation as required to maintain the plant properly was assigned to each division. In all cases, the hand tools required were furnished by the employees.

5. Shutdown of Plant

After operations ceased at this plant on May 21, 1943, the Engineering Department had the responsibility of putting all buildings in a standby condition and the preparation for storage or shipment of all movable production equipment. This work was completed the latter part of August, 1943.

6. Operations during Standby Period under Radford

On September 18, 1943, Contract W-ORD-492, dealing with operations of New River as a Bag Loading Plant was terminated. On September 19, 1943, the responsibility of all the maintenance activities at New River were transferred to the Maintenance Department at Radford Ordnance Works.

At this time the operation of the Service Station was transferred from the Engineering Department to the Service Department. The operation of the River Pumping Station was transferred from the Engineering Department to the Guard Department, as it required that a guard be on duty at the Pumping

Station at all times. The responsibility for the operation of intra-plant railroad was changed from the Engineering Department and was placed under the transportation superintendent at the Radford Ordnance Works.

Shortly after the plant came under Radford's supervision, Change Order No. 20 to Contract W-ORD-462 was issued which called for increment packaging of mortar charges. The management decided to install facilities at New River to perform this operation.

Line No. 4 was chosen to perform this work. The Heating System was put back into operation; motors were installed, as required, in the Loading Building to drive the crimping machines; and the Magazines and Canteen buildings were put into operation. During the early operations, the increments were placed in the cellophane envelope by hand. Soon after operations had started, the Engineering Department devised mechanical stuffers that appreciably increased production rates.

Operations continued along these lines until May, 1944, when Change Order No. 22 was issued to the basic Radford Contract, calling for loading flash reducers. In order to accept this work, the Dry and Screen Unit had to be rehabilitated and put into operation.

Igniter lines had to be set up, including additional sewing machines. Scales had to be procured and set up, and numerous volumetric cups were made to determine volumetrically the weight of the charge. Shortly after Loading Operations started, work was started toward the development of a volumetric machine that would load all three channels of the flash reducer at one time. The development of this machine was completed, and machines were constructed in time to equip new Flash Reducer lines built at this plant during the latter part of 1944.

C. Activities - Reactivation as a Loading Plant

Upon receipt of proper authority from the War Department that the New River Ordnance Plant was to be reactivated as a Bag Loading Plant, immediate

steps were taken to set up an Engineering Department at New River, independent of the Radford Plant. The organization of the New River Engineering Department was essentially completed during August, 1944. Activities of the Engineering Department were chiefly as follows:

1. Reactivation Period

Necessary construction work and installation of equipment needed for the reactivation of the New River Ordnance Plant was in charge of Mr. H. E. Carlin, project engineer at the Radford Ordnance Works. The actual work was performed by the construction contractor, Mason and Hanger Company. During this period, the New River Ordnance Plant Engineering Department assisted the project engineer in performing the following:

a. Preparation of all material lists for process equipment.
b. Inspection of installation of process equipment.
c. Fabrication of certain items of process equipment (check-weights, powder spout gates, etc.)
d. Design and construction of equipment for packing and air-testing the 155 Howitzer charges.
e. Conditioning of process equipment (sewing machines and scales) before installation.

The assistance referred to above given to the Radford project engineer started in July of 1944 and continued into June of 1945 when all construction work was stopped. In addition the New River Engineering Department assisted Mason and Hanger's Construction Forces in the following ways:

a. Serviced construction equipment.
b. Applied asphalt surface on all roads as directed.
c. Seeded and sodded areas after construction.
d. Performed all drilling and blasting necessary for the construction of new buildings and building additions.
e. Installed drinking-water fountains in Explosives Buildings.
f. Installed magnetic thread cutters on sewing machines in Bag Manufacturing buildings.

During the latter part of March, 1945, Mason and Hanger Company entered into a closed-shop agreement with the unions and, as a result, the New River Ordnance Plant Engineering Forces ceased performing work on the above, with the exception of drilling, blasting, and surfacing of road ways, which was

continued until construction work was stopped.

2. Maintenance Operations

The Engineering Department was set up as shown on the chart on page 348. The functions of each division were essentially as follows:

a. Electrical Maintenance

This division was in charge of the general maintenance foreman, who was responsible to the plant engineer for the maintenance and repair of all electrical equipment and lines on the plant.

During this period of operations, this department was not further broken down. The same equipment as shown on page 366 was supplied by the company. During normal operations twelve employees were employed in this division.

b. Mechanical Maintenance

This division was under the direct supervision of the maintenance superintendent, who was responsible to the plant engineer for the maintenance of all mechanical equipment and new construction to be done on the plant. This division was further broken down into the following sub-divisions:

(1) Automotive

This sub-division was under the supervision of the maintenance supervisor, who was responsible to the maintenance superintendent for the repair and maintenance of all motive equipment on the plant.

During this period the Motive Equipment Division did not operate the Service Station. During normal operations there were fourteen employees in this division, who serviced during peak operations of the plant approximately three-hundred pieces of motive equipment.

(2) Carpenter Shops

This sub-division was in charge of the general maintenance foreman, who was responsible to the maintenance superintendent for all carpenter work, painting, and construction as was necessary. This division

normally employed fourteen craftsmen.

(3) Line Maintenance

This sub-division was in charge of the general maintenance foreman, who was directly responsible to the maintenance superintendent for the maintenance of all production and maintenance equipment except scales and sewing machines on the lines and in the Bag Manufacturing buildings. The personnel of this group consisted of 3 men (1 per shift) for maintenance of increment-packaging equipment, with 4 additional men being assigned to duties in the other Production areas.

(4) Scales

This division was in charge of the general maintenance foreman, who was directly responsible to the maintenance superintendent for the maintenance and care of all scales and volumetric weighing devices in the Production buildings, and in addition, for the maintenance of all sewing machines in the Explosives Area. This sub-division was set up for 24-hour operations. The personnel for each shift consisted of 1 scale foreman, 2 scale mechanics in the Scale House, and 1 mechanic in each Operating Building.

In addition to the maintenance of scales and sewing machines, this division, upon receipt of order from the Control Division, prepared the inside weights for the Shadowgraph Scales and the check-weights for each powder lot. The finished weights and check-weights for each powder lot were checked by the Government inspectors before being used by the Loading Department.

Whenever it was necessary to change the inside in the scales for powder-lot changes, one of the men from the shop brought the weights from the Scale Shop and helped the line mechanic change the weights. The time involved in changing the weight of a powder-lot change was approximately fifteen minutes.

The scale mechanics on the lines also checked the accuracy of the scales every two hours and made such adjustments as was necessary.

Spare heads for sewing machines were located in each line to cut down lost operating time, and the mechanic on the line would remove any machine giving continual trouble, replacing it with the spare machine. The machine giving the trouble was then sent to the Sewing Machine Repair Shop for repairs. Two Sewing Machine Repair Shops were provided -- 1 in the Scale Shop for the Smokeless Loading Lines and 1 in the Flash Reducer Canteen Building for the Black Powder Loading Lines.

(5) Sewing Machines

This sub-division was in charge of the general maintenance foreman, who was responsible to the maintenance superintendent for the maintenance and repair of all sewing machines in the Bag Manufacturing Building, as well as the repair of the sewing machines on the Loading lines. The personnel for each shift consisted of 1 sewing machine foreman, 2 sewing machine mechanics repairing sewing machines used in the Explosives Area, and 1 sewing machine mechanic for every 50 sewing machines in operation in the Bag Manufacturing Building.

Spare sewing-machine heads were provided to cut down time while machines were down for repairs or adjustments.

During the early stages of reactivation of the plant, the duties outlined in (4) and (5) above were as follows:

(a) Scale mechanics in addition to making up weights maintained and repaired all equipment in the Smokeless Loading Areas.
(b) Sewing machine mechanics maintained and repaired all equipment in Black Powder Loading Area as well as sewing machines in the Bag Manufacturing Building.

This division of responsibility and duties was not as satisfactory as that outlined above.

As a result of adding the Scale and Sewing Machine Repair Department to the Engineering Department, the following major equipment was added to the list of equipment shown on pages 364-366 and 371.

1 - 1000-oz. Henry Troemner Precision Balance
2 - 20-lb. Henry Troemner Double Pan Balance (0.01 oz.)
2 - Sets Master Weights, 1 oz. to 10 lbs.
(One Set Certified by Bureau of Standards)
2 - Sets Master Weights, 0.1 oz. to 1 oz.
(One Set Certified by Bureau of Standards)
2 - Sets Master Weights, 0.01 oz. to 0.50 oz.
(One Set Certified by Bureau of Standards)
1 - 9"-x-36" South Bend Bench Lathe
2 - Delta Bench Drill Presses - 1/2" Capacity
3 - Delta Bench Grinders - 6" Wheels
3 - Sewing Machine Test Tables and Drives

In addition to the major equipment listed above, the company furnished belt pliers to all mechanics when required. All other hand tools were furnished by the employees.

c. Utilities

This sub-division was under the direct supervision of a general maintenance foreman, who was responsible to the plant engineer for water, heat, water filtration, sewage, Sewage Disposal Plant, outside Water and Sewage lines, and plumbing and piping of the entire plant.

Operations were essentially the same as outlined on page 367 except that all plumbing and piping activities were included, and there were no supervisors for the sections. The number of employees in the division were as follows:

Heating	13
Water and Sewage	8
Piping and Plumbing	2

With the exception of the Piping and Plumbing Section, which worked the day shift six days a week, this division was set up for 24-hours-a-day, 7-days-a-week operation.

Operations of the River Pump Station were performed by guards in the same manner as during the stand-by period.

d. Roads and Grounds

This division was under the direct supervision of a general maintenance foreman, who was directly responsible to the plant engineer for the maintenance, repair, and construction of all railroads, roads, fences, and grounds on the entire plant.

The activities of this division were the same as outlined on page 371 except that the operation of the railroads was left under the supervision of the Radford Plant transportation supervisor.

The equipment furnished this division was the same as shown on page 371 except for the two locomotives. Personnel in this division varied between 25 and 35 employees.

3. Projects

During the reactivation of the plant, the Engineering Department performed work on three major projects.

a. Project W-441

This project was made up by the Radford Engineering Department and called for building the necessary partitions and auxiliary equipment required to install four automatic machines for increment packaging on the "A" Side of Loading Line 4.

b. Project W-612

During the latter part of December, 1944, the Ordnance Department authorized the change in design of the increment zones for the 105, M2 Charge from round to square bags and recommended the changed design be put into production as soon as possible. The company had on order a Schmutz Press, which could be used for this purpose, but the delivery date was indefinite. In view of this fact and also in order to provide equipment that could be used in case of a breakdown of the Schmutz Press, the department

proceeded to design equipment that would print and cut the square bags. After considerable experimenting with equipment on hand, it was proved that by properly synchronizing a 14" Artos Cutter with a platen printing press, tubing for aquare bags could be cut and printed. Orders for the equipment necessary were then placed. About the same time, the Ordnance Department approved the use of random printing on the bags rather than a single impression on each bag, and steps were taken immediately to take advantage of this change. By redesigning a 6" Artos Cutter that was on hand (increasing width to 16" and removing cutter) to be used as a feeder synchronizing the feed with a 10"-x-15" platen press, it was possible to print on one press 4500 lineal-feet-per-hour of tubing for square bags. Two presses were equipped with plant modified feeders which printed cloth for all the bags required. The tubing was then cut on an Artos Cutter. Since construction of the plant was still in progress, the equipment necessary for the production of the sewing and tubing was purchased or fabricated on construction accounts. Because of slow delivery of equipment and curtailment of production, the project as originally submitted was not completed.

c. Project W-644

As a result of the success experienced in developing the printer and cutter on Project W-612 early in May, 1944, certain changes were requested in the design of M1 Flash Reducer bags so that similar equipment could be used. The bag-design changes were accepted and a project prepared and accepted by July 15, 1945. Equipment was ordered at once, and work was started in the shops fabricating the necessary auxiliary equipment. The plant was shut down before this project was completed.

4. Work Orders

All work requests to the Engineering Department, where building or equipment was to be repaired or restored to its original state without any change in design or material, were handled orally or on memoranda.

Work not falling in the above classification was handled on a Work Order (Form 299). The Work Order was made out by any authorized employee, in quadruplicate, specifying the work to be done and the reason, and was forwarded to either the operating manager, the assistant operating manager, or the administrative assistant for Operating Department approval. After the Work Order was approved by the Operating Department, it was forwarded to the plant engineer, who before approving did the following:

(1) Checked with Radford property control engineer to determine if a project was required.
(2) Checked to see that proper charge accounts were on order.
(3) Assigned serial numbers to order and forwarded three copies to proper shops.
(4) Sent fourth copy (pink) to property control engineer.

In assigning a Work Order to a shop, the order was assigned to the shop that would have to perform the larger part of the work. Shop Cross Orders were used between divisions of the Engineering Department requesting work to be done.

After work was completed, the shop to which the order was sent distributed copies as follows:

(1) Original with any Cross Shop Orders retained in department files.
(2) One copy (blue) returned to department originating order, showing date completed and cost.
(3) One copy (buff) returned to plant engineer, showing date completed and cost.

From the time the Work Order System was started in 1944 to the close of operations, 733 Work Orders were processed.

5. Automotive Equipment

During operations as a Bag Loading Plant, under Contract W-ORD-642, the following automotive equipment was assigned to the Engineering Department:

Plant Engineer	1 Sedan
Electrical Department	1 Sedan
	1 3/4 T. Pick-up
	2 1/2 T. Pick-ups
	1 Linesman Truck

Mechanical Department	1 Sedan 2 Carry-alls 1 Grease Truck 7 Pick-ups 2 Weapon Carriers 1 1½ T. Body Truck 2 Station Wagons
Utilities	5 Pick-ups 1 Dump Truck 1 Station Wagon 1 Full Truck
Grounds and Roads	4 Dump Trucks 1 1½ T. Stake Body Truck 2 Station Wagons 2 Pick-ups 2 Weapon Carriers 1 Tar Distributor 1 Winch Truck 1 Water Tank Truck (2,000 gals.)

6. Shutdown

After the conclusion of the War in Europe, the Engineering Department started to prepare a "Manual of Shutdown Procedure" for this plant. At the time of preparation of the manual, the extent to which the plant was to be shut down was not known, so the manual was prepared to allow for the following possible actions:

a. Retained Capacity

Shutting down equipment not required for the retained capacity of the plant as shown on schedule transmitted by the Field Director of Ammunition Plants under date of June 30, 1945.

b. Storage Depot

Shutting down plant as was then in operation or as kept for retained capacity, and operating plant only as a Storage Depot.

c. Shutdown

Shutting down plant from either of conditions mentioned above to a complete shutdown of plant and facilities.

The manual was completed and transmitted to the commanding officer for his and higher approval on August 15, 1945.

Upon receipt of work from the Ordnance Department as to the degree of shutdown required, the Engineering Department was responsible for the shutting down of the plant in accordance with the "Approved Manual for Shutdown Procedure."

7. Absenteeism

The graph on page 384 shows the percent of absenteeism for the Engineering Department during the period, September, 1944, through September, 1945.

The absentee rate for the Engineering Department was considerably below that for the remainder of the plant. It is an interesting fact that approximately one-half of the absentees were laborers in the Roads and Grounds Division. The high rates in December, 1944, and January, 1945, were largely due to inclement weather. A very large percentage of the absences was due to transportation: "car broke down," "missed ride," "driver didn't work," etc.

8. Safety Record

Year	Lost-time Injuries	Days Lost	Frequency	Severity
1941	0	0	0	0
1942	15	194	12.6	.163
1943	0	0	0	0
1944	3	331	*	*
1945	0	0	0	0

* Departmental man-hour record incomplete during stand-by period.

There were no lost-time injuries reported in 1941, 1943, or to date in 1945. There were 15 injuries in 1942 and 3 injuries occurred in 1944 during the stand-by period. No departmental break-down of man-hours was made during the time the plant was directly under Radford supervision. Between the time that independent records were re-established on September 1, 1944, and September 1, 1945, 368,739 man-hours had been worked without a lost-time injury.

Chapter XIX

BAG MANUFACTURING DEPARTMENT

1. Responsibilities

During the life of Contract W-ORD-492, the Bag Manufacturing Department was charged with the manufacture of bags and igniter-protector caps for the loading of propellant and igniter charges.

After the reactivation of the New River Ordnance Plant under change order to the Radford Ordnance Works' Contract W-ORD-462, the Bag Manufacturing Department was also charged with the manufacture of flash-reducer bags.

The responsibilities for the performance of the functions required to produce the finished product were allocated to the Stores, the Dye and Laundry, the Cutting, the Printing, and the Sewing departments, which sections collectively comprised the Bag Manufacturing Department.

a. Stores Section

The Stores Section functioned under the immediate supervision of the stores foreman, who was in turn responsible to the chief clerk of the Bag Manufacturing Department.

Stores was charged with the responsibilities of ordering and receiving from the Warehousing Section of Works Supply all materials required for the manufacture of bags and protector caps, as well as with the storing, and the issuing of these materials.

Stores was further charged with the responsibility of following this material through the various operations until the finished product was returned for storing and for delivery to the Loading lines as required to meet production schedules.

Stores established and maintained daily records and reports on detailed production activities, materials consumed, and materials on hand.

b. Dye and Laundry Section

This department, functioning under the immediate supervision of the dye foreman, was composed of two separate and distinct sections, the Dye Section and the Laundry Section.

The Dye Section was directly involved with the manufacture of bags and igniter-protector caps and performed functions essential to these operations.

The Laundry Section, on the other hand, performed no functions either directly or indirectly connected with the finished product.

(1) Dye Section

The Dye Section was charged with the responsibilities of dyeing all cloth that required a special color in the manufacture of bags for the following types of charges:

155 MM How., M2 White Bag	(Igniter only)
155 MM How., M3 Green Bag	(Bag & igniter)
155 MM Gun, M1	(Igniter only)
8" How., M1, M2 White Bag	(Igniters only)
10" Gun, M1888 and M1895, Stack-type Igniter Assembly for 4-7" AA Gun	(Igniters only)
12" Gun, M1888 and M1895	(Igniters only)
8" How., M1 Green Bag	(Bag & igniter)
Flash Reducer M1 for 155 MM Gun, M1	
155 MM How., M1, M4A1 White Bag	(Igniter only)

A three-compartment H. W. Butterworth machine was used in performing the dyeing, the washing, and the drying functions. This machine had 3 sets of nip rollers, with 5 dip rollers in the dye vat, 2 rollers in the settling vat, and 2 sets of rollers in the washing vat. Driven by D. C. motors, this machine required a generating unit. The motors were equipped with rheostats which compensated for any variation in the speed of the cloth as it moved through the vats. Stainless-steel dye-mixing vats were set up on a platform, and motor-driven agitators mixed the dye solution as it was being boiled. A centrifugal pump attached to a stainless-steel reservoir effected constant circulation of the dye solution between the dye vat and the reservoir.

Held in line by a Foxwell guide, the feeding of the cloth to the machine could be changed from 12 yds. to approximately 50 yds. per minute.

Red and green analine dyes were used. The dye mix was changed during the dyeing functions and was not an absolute fixed formula. Common table salt was used to set most of the dye solutions.

Red dye was used in dyeing all cloth from which bags were to be manufactured for loading with black powder.

Green-dyed cloth designated the field use of the finished charge.

Stretched to its original width after passing through the dyeing and washing processes by a Thomas Leiland stretching machine, rollers carried the cloth over twenty-one drying drums to a rewinder at the end of the machine.

A Number 55 railway sewing and rolling machine was arranged to handle cloth up to 42" wide and was equipped with a roller cradle at the front with wooden rollers in the bottom to receive cloth up to 18" in diameter. Equipped also with a Singer sewing inch head, Style 24-35, which made a chain stitch with one thread, this machine was used to rewind and to measure rolls from bolts of cloth the ends of which were butted together and sewed on the sewing-machine head.

(2) Laundry Section

The Laundry Section was charged with the responsibilities of mending, washing, applying fire-proof treatment, and drying of coveralls for employees of the entire plant. Coveralls for the women employees were also pressed.

The laundry was well prepared to handle these functions since it was equipped with the following:

1 - 42"-x-64" Hoffman standard silver crest all-monel washer, equipped with automatic washer inlet valve and a non-recording washometer.
2 - Hoffman 30" solid curb extractors, having all safety features, foot-operated brake, and monel side sheeting baskets.

3 - Hoffman 36"-x-30" open-type tumblers.
6 - American No. 44 super Zarmo air drum pressers, equipped with 2-hand tandem operation.
6 - Hoffman No. 2 galvanized truck tubs.
1 - Worthington No. H-1500-L air compressor with Asne tank.

c. Cutting Section

The Cutting Section functioned under the direction of shift supervisors who were in turn responsible to the cutting supervisor.

This department was charged with the responsibilities of the testing and the cutting of all cloth to conform with dimensions as shown on drawings covering the propellant- or igniter-charge bag for which the cloth was being cut.

A Scott testing machine having a capacity of three hundred pounds and capable of testing cloth as outlined in U. S. Army Specifications Number 50-11-39B, dated May 17, 1940, was used. This machine was equipped with a motor and a "V" belt drive so arranged that the lower or pulling jaw traveled at a uniform rate of 12" per minute under no load.

Cloth-slitting functions were accomplished with a Johnson slitting machine which rewound the cloth after it had been slit in various widths. This machine was also used to slit all puttee tape used in the putteeing of the 155 MM Gun, M1 Charge.

Twenty Stein table sections, 16' long by 54" wide with steel frame work and adjustable legs, were made into four cloth-cutting tables which were equipped with laying-machine tracks on edge.

Cloth-spreading machines were used in conjunction with cloth-cutting tables and were equipped with attachments for laying 42" bolt material.

The number of layers of cloth depended on the type cloth being used. Grade "C" cotton cloth could be laid 500-deep. After the cloth was laid, patterns were marked in such a manner as had previously been determined would result in the least waste.

Cloth-cutting machines and overhead rails completed the cloth-cutting

equipment.

d. Printing Section

The Printing Section functioned under the supervision of the printing supervisor and was charged with the responsibilities of printing the type of charge, the charge number, and the powder-lot number on all bags. Also the amount of black powder and the type of charge was printed on all igniters.

Further responsibilities included printing data cards, making marking plates for stenciling containers, and printing forms used by the entire plant.

The following equipment was used in performing Printing Department functions:

13 - 10"-x-15" Brandtjen and Kluge 3-roller platen presses.
4 - 12"-x-18" Brandtjen and Kluge 3-roller platen presses.
2 - 10"-x-15" Chandler and Price Craftsman job presses with Rice automatic feeders.
2 - 14½"-x-22" Chandler and Price job presses.
1 - 30½" Diamond power paper cutter with Challenge safety devices.
1 - 36½" Diamond power paper cutter.
1 - Henry and Wright 25-ton dieing machine, equipped with automatic double-roll feed.
6 - No. 2 L.&J. inclinable-type power punch presses complete with guarded drive.
1 - Challenge power paper-drilling machine.
1 - American Type Founders precision rubber plate machine.
1 - Hamilton steel-constructed imposing table, 59"-x-51"-x-2" thick.

Additional equipment included drying racks, cabinets, and fonts.

The open job presses were all used to print the nomenclature on the various types of bags to be manufactured. Each lot of powder was kept as a separate unit by printing the lot number of the bags. It was necessary to use rubber plates to print the cloth because metal type would lose its surface at once and be ruined, whereas rubber plates could be made from bakelite master plates which lasted for a week of continuous running.

The Diamond power paper cutters were used to cut cloth straps for charges as well as for making octagon and square spacers for fillers for powder containers. The Henry and Wright dieing machine was used to stamp aluminum plates for identification of separate loading charges. This stamping

press was the first machine installed in the Bag Manufacturing Building.

e. Sewing Section

The Sewing Section was charged with the responsibilities of performing all sewing functions necessary to produce the finished product.

The Sewing Section equipment consisted of the following:

182 - Model 241-2 lock-stitch single-needle Singer sewing machines, rated at 5,000 RPM per minute.
38 - Model 112-W-140 double-needle 1/8"-gauge lock-stitch Singer sewing machines, rated at 3,500 RPM per minute.

Each machine was complete and was mounted on individual adjustable stand and table 30" high. Table tubs were 1 3/4" thick by 29" wide by 54" long. The tables were equipped with 2-spool thread unwinders and automatic bobbin winders. A number of extra heads were maintained for use as spares.

The Sewing Room was equipped with racks on each side to keep the cut and printed pieces of material for each powder lot as well as the different-type charge bags.

Four inspection tables completed the Sewing Section equipment.

2. Organization

Actual organization of the Bag Manufacturing Department was not completed until October 1, 1941. However, preparations for the organization of this department began April 14, 1941, when Mr. O. B. Case was hired by the Home Office to be superintendent.

A group of employees hired as potential key personnel were, at the conclusion of a Training Program conducted at Picatinny Arsenal during the months of May and June, 1941, assigned the task of conducting an intensive Training Program at New River. Their knowledge of operations and leadership qualifications were the deciding factors in determining the responsibilities entrusted to each of this group.

Mr. James W. Dougan, hired May 1, 1941, was made chief supervisor. On December 1, 1941, Mr. Dougan was promoted to acting superintendent and on

January 1, 1942, to superintendent, succeeding Mr. Case who had been promoted to plant superintendent.

As a result of orders from the Ordnance Department, production at New River ceased May 24, 1943, and with one exception, key personnel of the Bag Manufacturing Department were transferred to other plants.

Mr. Frank D. Marvel, who was employed May 18, 1941, by the Home Office and who had served in the capacity of printing supervisor, was retained to supervise the work of putting bag-manufacturing equipment into a stand-by condition. Upon completion of this task, Mr. Marvel was transferred to the Radford Ordnance Works.

Preparing for the reactivation of the New River Ordnance Plant, Mr. Marvel was recalled from Radford January 1, 1944. On June 1, 1944, Mr. Marvel was made supervisor of the Bag Manufacturing Department and on July 1, 1944, he was promoted to supervisor of production.

3. Training

a. Picatinny Arsenal

A group of potential supervisory personnel was brought together at Picatinny Arsenal in the month of May, 1941, to be trained in operating functions required for the manufacture of propellant- and igniter-charge bags.

Given definite assignments by Mr. O. B. Case, who accompanied them, the 9 women and 6 men comprising this group were trained under the directions of Mr. R. G. Stilwell and Mr. L. E. Hazen, supervisor and assistant supervisor of Bag Manufacturing and Loading departments at Picatinny.

The women of this group had been selected from the Textile Industry and were consequently qualified sewing machine operators. Each was, however, trained in the various operations required for the manufacture of bags for the different types of charges.

Included in this group was Mr. Larner Peak, who had been detailed by the Singer Sewing Machine Company to supervise the installation of sewing machines at New River. Mr. Peak accompanied this group for the purpose of observing the grouping of machines, which were arranged according to the different types of charges for which the bags were to be manufactured. Also Mr. Peak studied the setting of these machines for the number of stitches-to-the-inch according to specifications for each type of bag.

After thorough training and actual performance of the functions to which they had been assigned, all spent a short time observing Bag Loading Operations in order that each would have a better understanding of the importance of Bag Manufacturing to Bag Loading.

b. New River Ordnance Plant

Preparations for the inauguration of an intensive Training Program at New River began July 1, 1941, after the return from Picatinny Arsenal of a group of supervisory personnel who had completed a sixty-day training period in order to be qualified to train others.

Warehouse 103, the first Inert Warehouse to be completed, was transformed into a training school. Equipment required for Bag Manufacturing Operation was set up in the south end of the building. Bag-loading equipment was installed in the north end.

Rest rooms were provided for the women, and a first-aid station was established and functioned under the supervision of Mrs. Mary Hiltzheimer, the first graduate nurse to be employed at New River.

During the training period, every operation was meticulously duplicated and every safety precaution was rigidly enforced. Cracked corn was used to simulate smokeless powder, and rice was substituted for black powder in the igniter bags.

The Training Program continued until the time that actual production for powder loading was started, and by September 24, 1941, more than three hundred operators had been trained.

4. Operating Building

Construction of the Bag Manufacturing Building was started June 15, 1941, but erection work was delayed because of a steel shortage; therefore the building was not accepted as complete until December 31, 1941, The building, 280' long by 240' wide, was divided in the center by a fire wall, was heated from the central heating system, and was equipped with four Century wet sprinkler systems. The building was also equipped with an automatic window-control system and safety-door exits. Exhaust fans were installed at each end of the overhead light bays.

5. Work Authorizations

Job orders prepared by and received from the Planning and Control Department authorized the performance of all bag-manufacturing functions.

These job orders authorized the manufacture of a specified number of bags of a stated size and for a designated powder lot, and included an overrun to offset rejections by inspectors in the Bag Manufacturing Department and at the Loading lines. Separate job orders covering printing functions were received. Forming a part of and attached to these job orders was a material list which showed the estimated quantity of materials necessary to complete the order.

6. Bag Development

a. 105 MM How., M2

New River's first sample bags for the 105 MM How., M2 Charge were copied from bags obtained from Picatinny Arsenal.

Having completed three complete charges, trial loadings were conducted during the month of September, 1941, at Line 4. Mr. F. E. Chelf, superintendent of scales, was on hand to verify the weight of powder loaded in each zone.

The bags were also gauged for diameter and height as compared against Government specifications. These trial loadings were witnessed by the chief Government inspector, the plant manager, the assistant plant manager, the plant superintendent, the Loading Line superintendent, the Loading Line supervisor, and the supervisor of the Planning and Control Department. The loadings were successful, and the bags were ruled to be in accordance with Government specifications and drawings by the chief Government inspector.

The sizes of the 105 MM How., M2 bags were never changed with the exception of those for five powder lots, which lots were unusual in their ballistic weights.

b. 155 MM How., M2 White Bag

The 155 MM How., M2 White Bag was developed and trial loadings made during the early part of November, 1941. Accepted by the Government, production loading of this charge began November 11, 1941.

c. 155 MM Gun, M1

Considerable trouble was encountered in determining the proper dimensions of the bag for the 155 MM Gun, M1. This trouble was traced to the puttee machine, which caused some charges to be soft and some hard, thus making a variation in the length and diameter of the charge.

In loading these charges, the Loading lines had difficulties with the third powder lot, the bags for which were cut according to the tested dimensions, but in loading these bags they were found not to be in accordance with the original test-bag dimensions. After much testing of the cloth and the methods followed in manufacturing the bag, the trouble was found to be in the stretching of the cloth in certain directions. It was determined that the cloth for the sample bag was cut with the height dimension perpendicular to the selvage of the cloth whereas the cloth for the powder lot was cut with the height dimensions parallel to the selvage. Upon loading and putteeing the

first bags for this powder lot, the charges stretched lengthwise out of proportion and would not gauge for length. It was found that in most instances cloth will not stretch lengthwise as much so as across the width.

Normal procedure in cloth weaving is to use a hard twisted thread for the warp or lengthwise thread and a soft thread with less turns per inch for the filling or vertical thread. As this was found to be true in 90% of the cloth received, it became necessary to purchase a cloth-testing machine in order to check each lot for tensile strength and stretch. The use of this machine, which conformed to United States Army Specifications mentioned elsewhere in this record, enabled the Cutting Department to determine the proper direction of the cloth from which to cut the bodies of the bags. After the purchase of this testing machine, each lot of cloth was tested for each powder lot, which lots varied in weight, thus necessitating different-size bodies for bases and increments.

Actual loading of this type charge began January 7, 1942.

d. 155 MM How., M3 Green Bag

Bag-manufacturing production for the 155 MM How., M3 Green Bag began in May, 1942. This charge required testing with each lot. The original test bag was copied from a Picatinny Arsenal Bag. Loading of this charge began August 3, 1942.

e. 8" How., M1 Green Bag

In July, 1942, the Bag Manufacturing Department developed from Ordnance Department blueprints the 8" How., M1 Green Bag and protector cap. Loading of this charge began August 3, 1942.

f. 8" Gun, MK, V13-A2

During July, 1942, the 8" Gun, MK, V13-A2 Charge was developed from Ordnance Department blueprints, as was also a protector cap. This charge was different from any that had been manufactured in that all of the sewing seams

were on the inside of the bag when finished. All of the seams were sewed on the outside along with a black-powder core running from one igniter on the top of the base bag to the igniter on the other end of the bag. In assembling the body of these charges, an off-the-arm sewing machine was used. After it had been sewed, the bag was turned inside out.

This charge was a lace-type charge requiring much care. Each lot was tested separately and varied considerably, making a change of dimensions necessary with each lot. Some smokeless-powder lots were found to be light and bulky in their ballistics, and the bag could not be made large enough to hold the powder and still meet specifications as to diameter and height. These lots were graphited for tight packaging, which process effected a smaller bag that could be gauged.

g. 10" Gun, Model 1888 and 1895

In the latter part of July, 1942, the 10" M1888 and M1895 Gun and Protector caps were developed from Ordnance Department blueprints. This charge was a lace stack-type.

The Combine Shops developed a metal cylinder which could be varied in diameter to hold the right amount of powder for each lot. After stacking the powder in this cylinder, the height of the powder was marked on the cylinder, and a bag conforming to specifications was made to fit this cylinder glove-tight. Each powder lot required different-size charges.

Loading of this charge began August 15, 1942.

h. Igniter Assembly, 4.7" A.A. Gun

During the latter part of October, a 4.7" anti-aircraft red bag was developed from Ordnance Department blueprints.

Loading production of this igniter assembly began in November and was discontinued in December, 1942.

i. 12" Gun, M1888 and M1895

Early in January, 1943, the 12" Gun, M1888 and M1895 Charge and protector cap were developed from Ordnance blueprints. This was a laced stack-type charge requiring a metal cylinder for bag sizes.

Actual loading of this charge began in January, 1943.

j. 105 MM How., M2 Anti-tank

During the month of March, 1943, the 105 MM How., M2 Anti-tank Charge was developed from Ordnance Department blueprints. This was an all-silk bag.

k. 8" Howitzer, M1, Propelling Charge M2 White Bag

The first days' initial production of the 8" How., Propelling Charge M2 at New River resulted in a high percentage of rejects because of cutting and breaking of the Grade "B" cotton cloth from which the bags were made. The rejects were classified as follows:

(1) Cutting of small holes in the cloth by individual powder grains because of normal handling of the charge as it was passed through the chute or placed on work tables before final assembly. Approximately 2% of the total bags handled failed for this reason.
(2) Cutting of small holes in the cloth as tie scraps were tightened and as bags rolled on table. About 95% of the total bags handled developed holes.
(3) Ripping of body or end one or two inches long, starting where a hole occurred at some part of the bag which was under tension. About 2% of all charges handled failed for this reason.
(4) Out of about 100 sets of bags started in production, 19 charges were completed before production was stopped. All of the 19 charges had developed holes or tears.

The cloth was tested before assembly in bags and found to have an average tensile strength of 38 lbs. in the warp and 28.1 lbs. in the fill. Several tests were made on a bag that had been rejected and showed 32 lbs. in the warp and 27 lbs. in the fill.

It was felt that the reason for the failure of the Grade "B" cotton was that it was so light that it could not absorb any shock or unit stress because of insufficient thickness to permit distribution of the force before

shearing took place.

Five bags made up of Grade "A" cotton were loaded and were handled a little more roughly than might normally have been expected. Although a few holes did develop, Grade "A" cotton was definitely determined to be more satisfactory than the Grade "B" cotton cloth.

As there seemed to be no way to adjust the dimensions of the Grade "B" cotton to eliminate the cause of failure, production was stopped pending receipt of permission to use either Grade "E" silk, as listed as an alternative on Drawing 71-9-171, or Grade "A" cotton, requested January 19, 1943.

Permission to use Grade "A" cotton cartridge cloth was received March 16, 1943, at which time production was again started.

7. Improvements

a. Laced-type Charge Bags

Original drawings required a seam in the back of the laced-type charge to join the two ends of the body. This necessitated the sewing of the seam from the inside to the outside of the bag, which with especial reference to the long narrow charge such as the 8" Gun Charge was a very difficult operation. This seam was the weakest point in the body of the charge and would occasionally break when the lacings were pulled tight.

Under date of September 21, 1942, it was suggested by Lt. Col. Fred H. Gallup, executive officer, Ordnance Department, in a letter to the Field Director of Ammunition Plants that the joining seams be made a part of the lacing flaps. It was contended that the elimination of the seam would produce a stronger bag since the tension in the bag would be continuous from one lacing flap to the other. Other advantages were enumerated.

After investigation and tests at Picatinny Arsenal of the suggested method of construction, drawings were revised to permit the use of the sug-

gested method as an alternative method of assembly.

This change was applicable to propelling charges for the following weapons:

8" Gun, M1888
8" Gun, Mk V1, Mod. 3A2
10" Gun, Mod. 1888 and 1895
12" Gun, Mod. 1888 and 1895
12" Gun, Mod. 1900
12" Mortar, Mod. 1912, Charge M5 and M6
14" Gun, M1907
14" Gun, M1910 and M1910M1
14" Gun, M1920 and M1920M2
16" Gun, Navy MK 11
16" Gun, M1919

b. Rejection Reasons

The following faults were considered reasons for rejection of propelling charges, which faults could be charged directly to Bag Manufacturing Department functions (Not all of these faults applied to all charges.):

Bag Tabs: Improperly sewed, too short, or improperly positioned.
Core and Gore: Improperly sewed, improper length, or improper positioning.
G-Straps: Improperly sewed, improper length, or improper positioning.
Improper Thread: Use of the wrong grade or type of thread (silk or cotton).
Oil, Wax, and Glycerin: Cloth spotted or marked.
Mismatched Bag Components: Improper pieces (e. g., bag marked "4" on one side and "6" on the other).
Bad Dyeing: Off-color or streaked.
Holes: Holes as a result of cutting by powder grains or as a result of tearing and varying from the size of a pencil lead to a tear 3 or 4 inches long.
Improper Printing: Weak impression, incorrect positioning, or incorrect nomenclature.
Improper Assembly: Cloth not positioned properly; two powder openings; one piece wrong side up, etc.
Bad Traces: Faulty sewing, incorrect length, or improper positioning.
Felt Pads; Incorrect size, improper cut, or poor sewing.
Seams: Improperly folded or sewed.
Horizontal Pleats: Cloth pleated, varying from 1 to 5 stitches long.
Wide Lips: Sewed too far from edge, which fact reduced the volume of the bag.
Tucked Lips: Edge of piece of cloth pulled under stitching, resulting in a weak bag.
Improper Reinforcing of Lacing Flap: Reinforcing piece inside lacing flap out of position to the extent of being ineffective.
Improper Stitching: Possibly loose stitching because of weak tension on machine or possibly too few stitches.

Narrow lips: One or both pieces of cloth sewed too close to the edge. (The extreme was in instances where the stitching ran over the edge leaving an opening in the bag. This rarely happened. However, occasionally the seam was so close to the edge that it pulled out easily.)

Improper Loops: The loops to which the igniters were secured possibly having been twisted or possibly not having been anchored to the bag properly.

Improper Dimensions: Parts of bag cut to improper size producing a finished bag that was out of proportion or one that was either too loose or too tight.

Bad Tie Straps: The tie straps being not sewed properly or not of correct dimensions.

Inferior Material: Any cloth or thread not meeting specifications.

The table below shows the total number of operators required to manufacture 5,750 complete charges of 105 MM How., M2 bags per shift in February, 1942. (There were 40,250 bags required.)

Charge or Zone	Operators	Single-needle Sewing Machines	Service and Pick-up Girls	Inspectors
1	16	16	3	
2	5	5	2	
3	3	3	1	
4	4	4	1	
5	16	16	3	
6	16	16	3	
7	16	16	3	
Loops	2	2	1	
Bodies (Matching & Kidneys Sewing)	6	6	3	Inspectors used in Operation
	4	4	2	
	88	88	22	4

Required 80,500 Printed Pieces - 8 Printing Operators

Cutting - (1 Cutter
- (2 Spreaders

The total number of operators required to manufacture 4,375 complete charges of 155 MM How., M3 Green bags per shift in February, 1942, is shown below:

Charge or Zone	Operators	Double-needle Sewing Machines	Single-needle Sewing Machines	Service and Pick-up Girls	Inspectors
Igniters	3	3		2	
5 Bodies	3	3		2	
6 Bodies	2	2		1	
7 Bodies	2	2		1	
Igniters (Quilting)	2	2			

Charge or Zone	Operators	Double-needle Sewing Machines	Single-needle Sewing Machines	Service and Pick-up Girls	Inspectors
(Continued)					
Assembling					
5	14		14	2	
6	8		8	2	Inspectors used
7	5		5	2	in Operation
	39	12	27	12	4

This charge was a 3-bag-charge with quilted igniters and printed straps.

Printed Pieces Required: 44,025 — 5 Printing Press Operators
Cutting — (1 Cutter
(2 Spreaders
Dyeing — 1 Operator

The table below shows the total number of operators required to manufacture 1,750 complete charges on 155 Gun, M-1 bags per shift in February, 1942:

Charge or Zone	Operators	Single-needle Sewing Machines	Double-needle Sewing Machines	Service and Pick-up Girls	Inspector
Igniters	1		1	1	
Base Bodies	2		2	1	
Increment Bodies	2		2	1	
Assembling					
Bases	4	4		2	Inspectors used
Increments	3	3		1	in Section
	12	7	5	6	3

Printed Pieces Required: 2 Igniters Base and Increment End per Charge
7,000 Printed Pieces - 1 Printing Press Operator
Cutting — (2 Cutters
(2 Spreaders
Dyeing — 1 Man, 1 Shift per 6 Days

This charge required absolute accuracy in the cutting and sewing, and the bodies were cut with the height dimensions perpendicular to the selvage as the stretch of the cloth affected the gauging of this charge.

8. Standby Orders

On May 24, 1943, by orders of the Ordnance Department, production activities at the New River Ordnance Plant were terminated. These orders further directed that all machinery and equipment be put into a stand-by condition.

Complying with these orders, the department disconnected all motors, painted bright spots of all machines with petroleum jelly mixes with fibre grease, and covered them. Sewing machines were covered with cloth covers, whereas water-proof paper was used to cover printing presses.

While the work of putting New River Ordnance Plant machinery and equipment into a stand-by condition was being prosecuted, other defense facilities were evidencing their need of this idle Government-owned equipment through requisitions directed to the Office of the Field Director of Ammunition Plants.

By the time stand-by condition orders had been completed, bag manufacturing machinery and equipment, having been declared excess, was ordered to be transferred to the custody of the War Department for shipment.

The cutting tables and cutting equipment were boxed and crated. Printing presses were mounted on skids and crated. All type and forms were broken down, recased, and boxed, which work took two compositors approximately forty-five days. Sewing-machine heads were packed in cartons ordered from the Singer Sewing Machine Company. Sewing-machine tables and legs were crated, and all motors and transmitters were boxed. The slitting and rewinding machines were mounted on skids and crated.

By September 15, 1943, all bag-manufacturing equipment excepting the dyeing machine had been checked into War Department Warehouses. This machine was checked to the War Department intact and left in the building, the keys to which were at that time given to the War Department.

Transfer of all equipment was effected by the Hercules Property Section through the medium of shipping reports.

9. Contract W-ORD-462

In accordance with the New River Ordnance Plant Reactivation Program under a change order to the Radford Ordnance Works Contract W-ORD-462, preparations were begun in April, 1944, to renew bag-manufacturing activities.

Transferred to the custody of the War Department after production under Contract W-ORD-492 was discontinued September 19, 1943, a majority of the bag-manufacturing equipment had been shipped to other defense facilities. The equipment remaining on the plant site was reinstalled in the Bag Manufacturing Building. Orders for the necessary additional equipment were immediately placed.

10. Flash-reducer Bags

Initial activities were confined to the development and manufacture of flash-reducer bags.

On May 1, 1944, 200 yards of Grade "C" silk and 200 yards of Grade "B" cotton cloth were dyed a scarlet or flag-red in accordance with specifications.

Six flash-reducer bags were manufactured from Ordnance Department drawings on May 9, 1944. After these bags had been completed, printing plates were prepared, which plates were used in printing lines on the cloth. These printing lines were to be followed by sewing machine operators when sewing the seams of the bag.

During the latter part of May, 1944, 600 complete flash-reducer bags were manufactured from silk cloth as were 300 from Grade "B" cotton cloth. It was definitely determined from loading and firing tests that the cotton-cloth bag performed equally as well as the silk bag. On May 31, 1944, new bag dimensions were received, and one hundred complete charges were manufactured. These charges were approved by the Ordnance Department.

A Training Program was inaugurated June 5, 1944, and new employees were instructed in the cutting, the printing, and the sewing methods required for the manufacture of flash-reducer bags.

Production orders specifying the use of Grade "B" cotton cloth were received June 16, 1944. Twenty-two hundred yards of Grade "B" cotton cloth were dyed June 18, and at 11 A. M., June 19, 1944, the manufacture of flash-reducer bags was officially started.

At the close of this record, minor changes had been made in the dimensions of these bags. Also cotton tape was being used, as all available 9/16" silk tape had been consumed.

11. Increased Activities

In July, 1944, Hercules was instructed to prepare estimates on a three-shift basis of the equipment that would be required to manufacture bags for the 105 MM Howitzer and for a new 155 MM Howitzer, M4A1 Charge. The tentative monthly schedule for the 105 MM Howitzer was far in excess of any previous production efforts.

Mr. R. H. Kunkel and Mr. P. C. Furbeck were transferred back from the Port Ewen Plant, reporting to Bag Manufacturing August 16, 1944, and immediately were placed in charge of shifts. Hercules started to train new operators at once to manufacture 105 MM How. bags and on September 5, 1944, the plant went into regular production on the first powder lot of 105 MM How.

The Sewing Room shifts were supervised by Mr. R. H. Kunkel, Mr. P. C. Furbeck, and Mrs. Virginia P. Brown; the printing shifts by Mr. Gordon Garner, Mr. Porter Downey, and Mr. Thomas D. Harrell; and the Cutting Department by Mr. Ulis E. Hamilton.

The Dye Room was operated under the direction of Mr. Euyles Forrest and was capable of dyeing all the requirements of flash reducers and igniters on one shift (about 10,000 sq. yds. per shift).

The Stores Department, in charge of Mr. H. L. Osborne, moved all materials through the various departments, checked all incoming materials, and checked and kept records of all bags manufactured and delivered to the Loading lines; it also inventoried all materials in process and storage each month.

The dimensions and methods of manufacturing 105 MM How. bags were changed occasionally, and, therefore, recording dimensions and methods at this period would be misleading. Hercules was constantly looking for new methods to employ in the manufacture of all of the bags.

Production on the 155 M4A1 bags was started November 7. This charge had to be gauged, and each lot of powder had to be weighed into bags to determine just the exact dimensions required so that it would gauge properly.

This charge consisted of a Base-3 Bag with igniter and tie straps; it also included 4, 5, 6, and 7 bags, all bodies being seamed with a double stitch. Igniters required a double stitch and quilting in centers. Since the manufacture of these charges was exacting, the operators had to be carefully trained. The dimensions of these bags were constantly changed to suit each powder lot. The Bag Manufacturing Department produced in December, 1944, the following:

111,985 Complete Charges 105 MM How., M2
64,914 Complete Charges 155 MM How., M4A1
226,872 Complete Charges Flash Reducers

This was done with the installation of new machinery going on all of the time.

There were on the payroll on December 1, 1944:

31 Men	640 Women	Total 671
5	131	136 New Employees
2	62	64 Left Employees
34	709	743 on Roll Dec. 31, 1944

It will be noted from the above figures that there was a large turnover of employees, which fact required much training time.

On December 30 the sewing machines set up for operators were as follows:

98 Single-needle Machines on Flash-reducer Bags
21 Single-needle Machines on 105 MM How., M2 Bags
29 Single-needle Machines on 155 MM How., M4A1 Bags
7 Double-needle Machines on 155 MM How., M4A1 Bags

The type of person being trained as an operator was more accustomed to housework and farm work and had practically no industrial experience. The average age was above that of the first group of operators employed; hence each one was given more extensive training than that given operators trained in 1941. The progress was, therefore, slow but every effort was made to keep pace with the demand for bags.

In December, 1944, Hercules was ordered to endeavor to bring production up to meet the schedules, and pressure was put upon Mason and Hanger Company to get the extra sewing machines needed and to install them. One hundred and thirty-nine additional 241-2 single-needle sewing machines were installed in January, 1945. The Employment Office was not able to recruit operators fast enough to fill bag-manufacturing requirements at this time.

The supervisors were called together to discuss a Training Program for all new operators. Assistant foreladies were sent to Job Instruction Training classes; and a method of instructing new operators was planned. The instructor on each shift studied this plan and put it into use. Mr. Garten of the Training Section cooperated with the instructors, and the results were very satisfactory. It was found that by reinstructing operators who had been here for several months that the quality and quantity of their work was improved. A follow-up program of checking each operator's production was also devised. If an operator's production was falling off, the instructor would investigate and assist the operator in overcoming whatever difficulties she may have had.

Instructors were given the Job Relations Training as soon as possible, and in due time they became personnel advisors as well as instructors. Attached is a mimeograph copy of the training instructions used by the Bag Manufacturing Department.

The delay in procuring and installing sewing machines and the shortage of operators caused bag manufacturing to fall behind the Loading lines in production. To maintain the Loading Line production, it was necessary to subcontract the sewing of 105 MM Howitzer Charge bags to the following outside manufacturers: Big Jack Manufacturing Company; Nickles Manufacturing Company; Coronet Manufacturing Company of Bristol, Virginia; J. A. Freezer and Sons of Floyd, Virginia; and Milan Manufacturing Company of Tupelo, Mississippi. These manufacturers made 1,533,587 complete sets of 105 MM Howitzer bags for New River.

The Bag Manufacturing Department cut, printed, and packed this material, as it was necessary that all materials for the bags be furnished by the department. This sub-contract work was started in February, 1945, and was stopped in April, 1945, for by this time production had improved, and the operators' efficiency had increased. The plant was then making all of the required charges for the schedules.

12. Inspection

The Inspection Section set up a final bag inspection similar to the final inspection on the lines. This helped in two ways: first, it maintained the quality of work and showed that the department was doing good work; second, it helped to reduce rejects and waste. Consequently, through the Inspection Section's cooperation, the lines did not waste very many bags.

One of the problems that arose involved the 105 MM Howitzer Charge Bag. The threads with which the bag was sewn broke after the bags were loaded. This was a 50/3 cotton thread issued by the Government and was the same size thread specified in the specifications. As soon as this was called to the department's attention, permission was asked to use a 20/3 thread. As this was a much stronger thread, the trouble was corrected.

On flash-reducer bags a 9/3 silk thread was used. This was cut by the needle on the cross seams and broke. Cotton thread size 20/3 was used in place of silk; this improved the flash-reducer charges to such an extent that no more difficulty was experienced with these charges in bag manufacturing or on the lines. The Final Inspection Section cooperated to the fullest extent with bag-manufacturing inspectors and with the service girls as well as with the shift supervisors.

The installation of magnetic thread cutters increased the efficiency of the operators on the sewing machines. At first the button was placed in front of the presser foot, but after making a study of positioning material and hand motions, it was placed about three inches to the left of the sewing-machine head. By changing the placing of material and the operator's hand motions, each operator's production was increased 25%. This thread cutter could have been improved upon by setting it up with a fast vibration; this then would sever the thread with the aid of a flat-edged knife and would eliminate attempting to keep sharp knives on the cutters.

The size of circles for 155 MM M4A1 bags had been standardized at 6" diameter, with the thought that the size of the circle need not be changed with the size of the body of the bag as determined by bag tests. It was found that altering the diameter of the circle with the change in body size eliminated the necessity of pleating the circle ends. This speeded up the assembling operations and eliminated rejects because of the folding under of pleats. The same effect was accomplished on the Base-1 Charge Bag of the 105 MM Howitzer by lengthening the body on this charge to suit the diameter of the kidney pleats.

The cleaning of the sewing machines became a problem, and in March, 1945, this was discussed with the supervisor of the sewing machine mechanics. From this discussion the supervisor evolved a plan of keeping the machines clean by using air and by cleaning them during rest periods and lunch periods.

From then on the machines were always clean and free of lint. The sewing machine mechanics were brought into bag-manufacturing meetings, and a much better cooperative spirit was noticed on each shift.

In May, 1945, a 10" Mortar Charge consisting of a base bag, three increment bags per charge, and an igniter bag was manufactured. The base bag was made like a large Base-1 Bag for the 105 MM Howitzer. The increments bags were designed to fit a mortar fin assembly.

The powder to be loaded in these bags was in the form of double-base pellets, graphited; it was necessary to make tight-fitting bags since this powder was shipped and packed closely. Difficulty was experienced in developing this charge so that it would gauge, because the tolerances were close. It was found necessary to make an instrument to punch out the increments. This "punch" was made by using a printer's cutting rule fixed into a block of wood scrolled out into the proper design. Punches to punch the cardboard pieces used to assemble these charges on the fins and cardboard diaphragms to hold the igniter charge in were also devised. These were made by wetting the disks, pushing them into a forming die, and drying them in the rubber plate machine.

As the bag-manufacturing production was ahead of schedule and as the Loading lines needed operators, seventy-five Class "A" operators were transferred from the Bag Manufacturing Department to the Loading lines on May 19 through the 21. These were excellent operators with good attendance records, and since the rate of pay was higher on the Loading lines, the transfer was considered a reward for good work and good attendance.

The manufacture of square bags for 105 MM Howitzer charges was begun the last of May to replace the round bags formerly used. When the manufacture of square bags was first suggested, and the savings that might be accomplished

worked out, Mr. Breidenstein and Mr. Marvel discussed the methods to be used and the necessary machinery it would require. In the course of this discussion, it was discovered that random printing of the tubing would be a major problem as the plant did not have a Schmutz Press, and the possibility of obtaining one was uncertain. It was suggested to Mr. Breidenstein that an open job press with an Artox cutter timed with the stroke of the job press to pull the tubing through the press be used. Mr. Breidenstein designed and engineered the building of the necessary equipment for two open job presses. Each press could print and rewind two rolls of tubed cloth at once, with different designs on each roll. One man could operate both presses and make the plate changes needed in a very short time. These presses were more flexible for this work than a Rotary press would have been, and they did not require a high-skilled pressman to operate them. As these presses would make 12,000 impressions per hour of four designs each, averaging 18,000 cut bags of the various sizes, the capacity was sufficient to more than meet the schedules.

Lock-stitch machines to sew the tubing were put into use. It was found that the bobbin ran out every 1¼ minutes, which fact resulted in time-losing stops and starts. Mr. Breidenstein requisitioned Union Special Chain Stitch Sewing Machines for this work, and when they arrived he rearranged all of the machinery for square-bag manufacturing.

The cloth was slit in the Cloth Room and placed on racks in back of the sewing machines, each size charge being placed in the rack for the machine set up to sew that particular charge. The rolls from the sewing-machines rewinders were placed in a rack located between the sewing machines and the printing presses. After being printed they were placed in a rack alongside the Artos cutter, arranged according to the charge number. This machine would cut six rolls at one time. As the bags were cut and put into boxes, they

were moved into the Sewing Room and placed on a rack at the end of the rows of sewing machines assigned to finish these charges. This shortened the movement of all processed material to a minimum. At this time the schedules were reduced, and the department was order to reduce back logs and stocks of completed bags. The department was also ordered to go on one shift, and one month later the plant was shut down. Consequently, there was no opportunity to show the savings and capabilities of this development.

The safety record of Bag Manufacturing Department was marred by one lost-time accident in the last period of operations from July, 1944, to August, 1945. This accident happened on a printing press. Mr. Fred Cornette was feeding a printing press on May 5, 1945, equipped with a standard safety guard. His hand was caught between the platen and the bed of the press, with the guard in position to push his hand out. No explanation of how this could have happened was arrived at, and the only explanation that Mr. Cornette gave was that he "was not paying any attention."

Throughout most of this period, new installations of machinery were being placed in the Bag Manufacturing Building. The average age of operators was 38 years; however, there were a few ladies working in the Sewing Room between 60 and 70 years of age.

The department experienced a 16% labor turnover, whereas the absentee rate averaged 11%. The large labor turnover was, presumably, due to the fact that most of the employees were recruited from towns several miles distant from the plant, and local housing facilities were inadequate. Most of the women were married and had no one to take care of their children. The "child" problem contributed to the absentee rate, and working three shifts seemed to make it very difficult for the regular employees.

In June, 1945, since the department was ordered to reduce the scheduled production of bags by one half, 607 employees were terminated. At the beginning of July, the plant was ordered to go on a one-shift operation and, therefore, the force was again reduced by terminating 397 employees. On August 17, two days after V-J Day, the Bag Manufacturing Department was shut down and 276 employees were terminated, 16 being retained to check and count materials. These were terminated in September.

Attached are charts and tabulations showing work accomplished by the Bag Manufacturing Department.

Chapter XX

BAG LOADING DEPARTMENT

1. Introduction

The function of the Bag Loading Department was to load, assemble, and pack for shipment propelling charges for separate-loading and semifixed ammunition for various caliber artillery weapons. Propelling charges for separate-loading ammunition were prepared in a manner that permitted the propelling charge and projectile to be separately loaded into the weapon. Propelling charges for semifixed ammunition were packed for shipment to Shell Loading plants to be placed into cartridge cases in order that the ammunition could be loaded into the cannon in one operation. The propelling charges could be adjusted for zone firing.

The component materials involved consisted of smokeless and black powder, increment bags, and thread. The operations involved in loading the various sizes and types of charges were closely related.

Methods and equipment varied according to the various types of charges. The charges ranged from the 75 MM Howitzer Charge, containing slightly less than one pound of powder, to the 16" Gun Charge, containing over 800 pounds of powder.

The characteristics of each lot of powder manufactured was found to vary with respect to ballistics; therefore, the exact amount used in each charge was determined for each lot of powder to be loaded. The size of the bags could be slightly increased or decreased in order to produce the desired muzzle velocity.

The charge of powder was gauged so as to produce a given velocity of the projectile at the muzzle of the gun for a given range of projectile travel.

2. Types of Ammunition

The three general types of ammunition in use by the military services during the war were as follows: separate-loading ammunition, semifixed ammunition, and fixed ammunition.

The first and second types of ammunition were the types loaded at Bag Loading plants. The third type was loaded at Shell Loading and Assembly plants.

a. Separate-loading Ammunition

The propelling charge for separate-loading ammunition is an assembly of propellant powder and igniter charge in cloth bags to form zones or sections for use in weapons in which the projectile propelling charge and primer are not assembled into a unit before loading into the weapon. The projectile is first placed in the gun. Then the propellant charge with the attached igniter is placed in rear of the projectile with the igniter at the rear end of the charge, so that when the breech block is closed, the primer is adjacent to the igniter.

Some charges of the separate-loading type are as follows: 155 MM Gun, M1, 155 MM How., M3, Green Bag; 8" How., M2, White Bag; 8" How., M1, Green Bag; 8" Gun Mk, W1-3A2; 12" Gun, M1888 & '95; 155 MM How., M2, White Bag; and 10" Gun.

b. Semifixed Ammunition

A semifixed round of ammunition is one in which the cartridge case containing the powder charge is not crimped to the projectile as it is in the fixed round. The powder charge is made up of one or more bags of powder, depending on the range to the target. Thus, the semifixed round permits the powder charge desired to be inserted and the projectile reinserted at the gun position. Semifixed rounds are used in the 75 MM Pack Howitzer; the 105 MM Howitzer, M2, M2A1; and the 75 MM Gun, M1897 and M48 Projectile when using reduced charges.

c. Fixed Ammunition

A fixed round of ammunition is one in which the bagged powder charge is placed directly into the cartridge case, and the projectile is inserted into the cartridge case and crimped. This type of ammunition is loaded at Shell Loading plants, where the complete round is loaded and assembled.

3. Organization

a. Training of Key Personnel

(1) Personnel Selected and Trained at Curtis Bay and Picatinny

With the outbreak of war in Europe in 1939 came the demand for the United States to manufacture ammunition. The Picatinny Arsenal in New Jersey and the Curtis Bay Loading Plant, Md., were the only two U. S. Army Loading plants available to the Government at that time.

At Picatinny Arsenal the Government operated a laboratory for the design and development of ammunition as well as plants for the manufacture of metal and explosives components of ammunition and for loading propellant charges. The Loading Plant at Curtis Bay, located in one of the Warehouses already on the site, was of a temporary nature.

A number of companies engaged in manufacturing commercial ammunition and dynamite in this country were called upon by European countries at war to produce ammunition components for them. Among these companies were Hercules, du Pont, Atlas, and others.

Hercules Powder Company received a contract on December 17, 1940, from the U. S. Government for the designing, the supervising, the construction, and the operating of a Bag Loading Plant to be built near Radford, Virginia.

Commercial plants had had no experience in the period since World War I in loading of propellant powder. Picatinny Arsenal was to be used as a guide in building the plant to be located at Dublin, Virginia. Trained personnel in such work existed only at the Government plants.

A Personnel Department was opened in Pulaski, Virginia, in the April of 1941, with Mr. A. R. Hance as personnel director. This department selected eight people for key positions at the plant, their job titles being superintendent of production, superintendent of bag loading, shift supervisor, supervisor of scales, line foreman, superintendent of bag manufacture, and chief inspector. Those named were Messrs. J. T. Sydnor, B. S. Owen, Paul Rice, F. E. Chelf, J. M. Dougan, William D. Huddle, C. D. Baker, and Frank McGavock. In addition the Personnel Department in Wilmington selected five persons for subsequent supervisory work. They were Messrs. O. B. Case, J. M. Sutcliffe, John Tosi, Frank Marvel, and Larner Peak.

This group was interviewed by the assistant manager, Mr. George Foulke, Jr., at Maple Shade Inn in Pulaski on April 11, 1941, and reported to the Wilmington Office on May 2, 1941, for a conference regarding company policies and training. Three men were assigned to Curtis Bay and the remainder to Picatinny Arsenal, with Mr. O. B. Case as leader.

These men reported to Picatinny Arsenal on May 3, 1941, where they were shown the work in general and given definite assignments for training under the direction of Mr. R. G. Stillwell, the supervisor of bag manufacture and loading. Each trainee spent fifty per cent of his time in observing the operation and the remainder in actual performance. Mr. L. E. Hazen, assistant to Mr. Stillwell, checked the progress of the trainees.

Mr. O. B. Case scheduled the group to be trained for a period of two months on the different phases of work as follows: Messrs. J. T. Sydnor, Paul Rice, and B. S. Owen in smokeless-powder propellant loading, black-powder screening and drying, and igniter loading; Mr. F. E. Chelf in scale maintenance and making scale check weights; Mr. J. M. Sutcliffe, chemist, in a brief course on explosives; Mr. J. M. Dougan in bag manufacturing;

Messrs. John Tosi and William D. Huddle in inspection; Mr. Frank Marvel in printing; and Mr. Larner Peak in maintenance of sewing machines.

The first group was sent to Curtis Bay Loading Plant for the second month of training. Messrs. Baker and McGavock were transferred from Curtis Bay to Picatinny Arsenal for their second month of training.

Hercules secured a second group of from 30 to 40 people to be trained at Picatinny Arsenal for 2 to 4 weeks as line foreman, assistant line foreman, foreladies, and Igloo supervisors.

(2) Objectives in Propellant Loading Training

In training for propellant loading there were three items which were considered in the order named: (a) safety, (b) quality, and (c) production.

(a) Safety

Correct safety clothing to be worn.

Explosives to be handled according to safety rules.

Personnel to be informed as to procedure on fire drills in case of fires, explosions, or blackouts.

(b) Quality

Produce ammunition that complied with Government specifications.

Select type and number of personnel needed to produce quality products according to production schedule.

Train personnel to produce quality work.

Check drawings and specifications for material requirements.

(c) Production

Check expenditure order for total number of each type of charges to be loaded.

Check time order for total number of days in which this order must be completed.

Check amount of order with number of working days to get the amount of production required each day to complete order as scheduled.

Check essential materials according to specification and quantity required to complete order.

Check the lots and shipping schedule of powder required.

Check for available personnel to produce daily production to meet the schedule.

Check expenditure orders.

Hercules received expenditure orders from the Ordnance Department. These orders listed the total number of charges to be loaded, date for production to begin on the order, shipping date after completion, size and type of charges, type of gun in which they were to be used, kind of powder, manufacturers of the powder lots to be used, total number of lots required, and the quantity of powder in each lot.

Changes sometimes had to be made in the orders. The Ordnance Department then sent an addendum which listed the changes; it then became an official part of the order.

Drawings and specifications were received for each order. They enumerated the terms of the contract and showed details of construction.

The drawings showed the dimensions of the bags to be used for each charge; the manner in which the sewing should be done to make the designated charge the proper size; the order in which the charges were to be assembled; the protector cap and the material of which it was to be made; the size of containers in which they were to be packed; the manner in which they would be packed; the size of the date plate, shipping plate, data card, and the data to be imprinted thereon.

(3) Training at New River prior to Production

All trainees were withdrawn from Picatinny and Curtis Bay arsenals to report to the New River Ordnance Plant on June 30, 1941. Each man received a badge and proper identification from the Personnel Department.

Production had not begun on the Loading lines at that time. Arrangements were made by management for a large Warehouse to be used in training the first group of operaters for the lines.

This first required the installation of loading equipment. Each trainee was assigned part of the installation according to the knowledge gained during his training period. This required approximately ten days.

The group of trainees was then set up as an Operating Organization consisting of a superintendent of bag loading, a shift supervisor, a line foreman, an assistant line foreman, a supervisor of scale shop, a stock clerk, and operators. A week of training followed, with this organization using inert materials. By this method all foreman trainees became familiar with the equipment and the use of inert materials.

At this time the necessary adjustments were made to put the equipment in good running condition before the new operaters were brought in for training. All training for powder loading was done in one end of the Warehouse, which was set up similar to a regular line, with powder hoppers, loading and sewing booths, an Assembly Room, a Packing Room, and a Scale Repair Shop.

The company hired three hundred operators during a three-week period starting about July 20, 1941. These were trained in this school until the first Loading Line was ready for operation.

b. Personnel Organization

The personnel of the Bag Loading Department was under the direction of the chief supervisor or superintendent of bag loading. Reporting to him from the Production lines were the shift supervisors, line foremen, assistant

line foremen, store's foremen, process inspectors, and operators; from the Scale Department were the scale supervisors and the shift scale foremen; and from the Loading Line Office, the chief clerk and other office personnel.

The duties of the personnel were as follows:

The chief supervisor or superintendent of bag loading was directly responsible to the management of the plant for maintaining expert coordination, co-operation, and unity of the Bag Loading Organization; for maintaining production schedules; and for bringing about a smooth relationship between the different units of the organization. This involved the direction of all phases of Production Operation, including the Central Line Office and all personnel under the supervisor's supervision. It necessitated constant daily contact with all phases of activity in order that all company policies and procedures be observed in the department.

The shift supervisor kept constant check on all phases of operation during his shift and cooperated with the other shifts in maintaining an unbroken flow of operation. He anticipated powder lot changes and saw that quality production was maintained and that safety regulations were carried out properly. A continuous written log record was kept in the Field Office in connection with all pertinent activities. He saw that production schedules on his shift were met, with necessary checking and handling of supervisory and operating personnel. He was directly responsible to the superintendent of bag loading.

A line foreman had complete charge of buildings and operations for one line. He saw that all equipment and buildings were in good working condition, and that production schedules and quotas assigned to his line were met. He determined the manner and method of meeting the schedules, always emphasizing quality and safety in all operations. He reported directly to the shift supervisor.

An assistant line foreman or house foreman had complete charge of the buildings assigned to him. He checked the building and equipment and observed and directed all phases of operations in his building. He was responsible for production schedules assigned to his building and saw that quality products were made and safety rules obeyed. A log record was maintained with pertinent developments and points of operations recorded to coordinate the work of the three shifts. He was directly responsible to the line foreman.

The store's foreman was responsible for keeping the line informed as to essential material on hand and what would be needed to complete the lot under manufacture. Magazines were checked before and after each shift, and loading reports were compiled. He had to see that all charges, before release from the lines, were checked by Government inspectors. All incoming materials were checked and inventories made at completion of lots. The store's foremen for all shifts had to work together and see that completed costs were assembled in one final report.

The scale supervisor was responsible for the maintenance repair work on the lines. This involved the repair and upkeep of all scale equipment, sewing machines, puttee machines, and other mechanisms common to the bag-loading activities. He directed the maintenance mechanics of scales and sewing machines and the line maintenance mechanics who repaired all the other equipment on the lines. He saw that all supplies and parts were available at all times and that all maintenance work met safety requirements.

The shift foreman of scales, sewing-machine repair, or line maintenance saw that maintenance on the scales and sewing machines, as well as other line work, was conducted in an efficient manner. He directed and allocated the work and saw that a repair man was on duty in each building in operation on his shift, for the purpose of keeping equipment in good operating condition. He was directly responsible to the scale supervisor.

The Loading Line Office was under the direction of the superintendent of bag loading. Here the necessary production and personnel records were maintained. Terminations, transfers, rate increases, store orders, time reports, absence leaves, accident reports, shift schedules, loading reports, material reports, inventory reports, etc., were handled in this office. Here the new employees were received and assigned to the lines after having received a safety and production talk. A log book was maintained for the direction and coordination of production on the three shifts.

c. Organization Chart

Organization charts will be found on the following pages: 446-449.

4. Summary of Operations

a. Start-up

The crew which was trained in the Warehouse with inert materials was assigned to actual powder loading at 6 P.M., September 24, 1941. Loading Line No. 4 was the first line to be put into operation. After this date as soon as each Loading Line and Igniter Line was completed, it was immediately brought into production. Four Loading lines and two Igniter lines were in operation by January 1, 1942.

b. Bag Loading Operations

(1) Dates Production Started and Types of Charges Loaded

The Loading lines were constructed to load the following types of charges, the production of which began on dates listed:

Line 4 - Production started September 24, 1941, in Building "A." The 105 MM How., M2, M2A1 type of charge was loaded. The charge is classed as semifixed loading.

Line 3 - Production started in October, 1941, with the 105 MM How., M2, M2A1 being the first type charge loaded. The following types were loaded at later dates: loaded at later dates: 105 MM How., M2, A.T.; 8" How., M2, White Bag; 8" How., M1, Green Bag; 105 MM How., M3; and 155 MM How., M3, Green Bag.

Line 2 - Production started in November, 1941, with the 155 MM How., M2, White Bag being the first type of charge loaded. The following types were loaded at later dates: 155 MM How., M3, Green Bag; 105 MM How., M3 A. T.; and 105 MM How., M3.

Line 1 - Production started in January, 1942. The 155 MM Gun, M1 was the first type charge loaded on this line. The following types were loaded at later dates: 8" Gun, MKVI; 10" Gun; and 12" Gun.

(2) Types of Powder Loaded

As previously stated, the function of this department was to prepare powder charges ready for insertion into the powder chambers of guns or into cartridge cases, depending on the type of gun in which the charge was to be used. This meant that two types of powders (smokeless and black) had to be loaded into bags; then the two types of loaded bags were combined into the completed powder charge.

The propelling charge to be bagged consisted of smokeless powder, whereas the igniting element for the charge consisted of black powder. Separate Loading lines existed for these two types of loading.

(3) Determination of Bag Sizes

Each lot of smokeless powder, prior to receipt at the Loading Plant, had to be tested for the amount of powder required to give the desired muzzle velocity. Not only did this amount vary between lots, but the bulk or volume of the powder between lots also varied. It was therefore necessary to determine for each lot of powder to be bagged the size of the bag to hold the proper charge of powder by weight and volume.

Tests to determine this information were made several lots in advance in order that the bags might be prepared by the Bag Manufacturing Department in time for use by the Bag Loading Department when the lines were ready to load the particular lots. Tests were conducted in the following manner:

1 Powder lots by number, in the order in which they were to be loaded, were furnished the Control Department by the War Department.

2 The supervisor of the Control Department contacted the superintendent of bag loading for the time and date at which he wished to make the test. The Bag Manufacturing Department kept a sufficient number of lots ahead in order not to delay the Loading Line Operations.

3 Both the Bag Loading and Bag Manufacturing departments were furnished copies of expenditure orders, giving the required weight of each charge (zone). From the given weight of each charge, the superintendent of bag manufacturing made up a trial set (required number per set) of bags for each powder lot that was to be tested.

4 The superintendent of bag loading ordered powder from the lots that were to be tested delivered to the Line Building where the test was to be conducted.

5 Representatives from the Bag Manufacturing Department, Scale Shop, and Control Department met with the superintendent of bag loading, the shift supervisor, and the line foreman in the building where the test was to be made.

6 The representative of the Scale Shop adjusted scales according to weight to be used. The scales were graduated to weight within 0.01 ounce, since each charge (zone) was weighed within 0.01 of an ounce.

7 Two operators were selected to assist in weighing, loading, and sewing the bags. Three bags were loaded for each zone on each lot tested.

8 Bags were inspected for looseness so as to allow for easy sewing. The loaded bags were then assembled in the usual manner by an assembly room operator.

9 The assembled charges were checked for tightness and gauged for diameter and height. For example, the 155 MM Howitzer, M4A1 had to gauge for length-minimum of 19 inches with the maximum not to exceed 21 inches. The diameter was not to exceed the maximum of 5.8 inches.

10 The charges were then sent to the Packing Room where they were packed in the regular containers and air-tested and checked in the regular manner.

11 The loaded containers were then returned to the room in which the bag test was being conducted.

12 The charges were then removed from the containers and rechecked for tightness, height, and diameter.

The group conducting the bag test decided from these checks whether the type (trial bags made) of bags used met all specifications. If the desired results were obtained, the order for bags for lots tested was placed with the Bag Manufacturing Department according to the dimensions of the bags used in the test.

(4) Processing a Powder Lot

A new powder lot was started on the line in the following manner:

1 It was determined that the correct amount of powder was on hand in the Powder Magazine in conformity with Job Order Specifications prior to the start of the Powder Lot Operation.

2 Scales and weights were checked as to size of charge to be filled and check weighed as to the correct powder lot number.

3 A check was made for availability of powder trucks and equipment for Line Operations.

4 Personnel assignments were made in accordance with the best judgment of line supervision.

5 Powder was transferred from Magazines to hoppers.

6 Operators in the loading booths, checking lanes, and Assembly and Packing rooms performed duties as assigned; and charges were loaded, assembled, inspected, packed, and sealed for Government acceptance.

7 All reports in regard to charges filled and packed on lots had to agree at all times with the Government inspector's check. Disagreements

were settled by recounting of materials by the store's foremen and the government men.

(5) Loading Methods - Smokeless Powder

Four general methods were used at New River in loading smokeless powder into bags. They were as follows:

(a) Loose Pour Method

The loose pour method was the simplest and fastest method of loading powder. It was used with semifixed ammunition. The powder was poured into a tub on a table in the loading booth from a powder hopper which was supplied from the second floor through copper tubing. The operator used a volumetric cup in transferring the powder from the tub to the calibrated powder cup on the scale. The cup of powder was weighed and necessary changes were made. The cup was passed to another operator who check-weighed the cup and powder on another scale. If correct the powder was poured into the increment charge bag by means of a funnel. The opening of the bag was sewed by the next operator. It was then ready for inspection and packing.

Detailed loading procedure follows:

105 MM Howitzer Loading

The steps in loading the charge for a 105 MM Howitzer, M2, M2A1 were as follows:

1 The powder was supplied to Service Magazines from Igloos by motor trucks.

2 The powder cans were removed from Magazines to Powder Service Halls on the second floor of the Loading Line where the powder was dumped into hoppers as needed. The hoppers supplied tubs in the loading booths.

3 A weigher in the loading booth filled the weigh cup with powder, placed it on the scale, and brought it to the desired weight of charge.

4 A check weigher rechecked the weight of powder and poured it into bag through a funnel.

5 A sewing machine operator sewed the opening in the bag and then placed the charges in the transfer chute.

6 The charges were removed from the transfer chute and inspected. They then were transferred to the Assembly Room.

7 The charges were then stacked on trays in order of the increment charges, with Charges 2, 3, 4, 5, 6, and 7 on top of the base charge - with large numbers up. These trays were distributed to the assembly tables.

8 The charges were assembled with a needle and silk thread according to specifications. Then they were transferred to the process scale inspector.

9 The charges were checked for total weight and proper sequence and were then sent to the Packing Room through transfer chutes.

10 The waterproof bags were placed in containers, with the top end down over the top edge of the container.

11 The container was weighed before packing.

12 The container was placed in front of the transfer chute, and as the charges were removed, they were placed in rows in the container.

13 The waterproof bag was twisted together at the top and tied with hemp twine.

14 The top was placed on a container, fastened with a hoop, and sealed with a lead seal.

15 The container was weighed to check for the correct number of charges.

16 The sealed loaded containers were placed on a truck and carried to the Service Magazines, where they were stacked to await shipping orders.

A total of fifity-five operators were required for a single operation in one building on the 105 MM Howitzer,M2, M2A1. The operators were

organized as follows:

Incoming Powder Men	- 2	Process Inspectors & Service Operators	- 8
Sewing Machine Operators	- 8	Service Operators for Assembly Room	- 2
Upstairs Powder Men	- 2	Weighers	- 8
Outgoing Powder Men	- 2	Assemblers	- 12
Packing Operators	- 2	Janitor	- 1
Check Weighers	- 8		

The building was under the supervision of 3 house foremen, 1 area foreman, and 1 line foreman.

The personnel of the buildings for other types of charges was organized in a similar manner.

155 MM Howitzer

The 155 MM Howitzer, M4A1, Charge (separate loading) was also loaded by the Loose Pour Method.

The steps in loading this charge were as follows:

1 Powder was brought to the Service Magazine by motor truck. The powder cans were taken to the second floor of the Operating Building on a service truck.

2 Powder was dumped into hoppers as needed. The hoppers supplied the tubs in the loading booths.

3 A weigher in the loading booth filled the weigh cup with powder and brought it to the desired weight of charge.

4 A check weigher checked for properly loaded igniters; rechecked the weight of the powder; and, if correct, poured it into the bag through a funnel.

5 A sewing machine operator sewed the opening in the bag, checked the work, and placed the charges in transfer chutes.

(The above procedure applied to all five individual charges that were assembled to make the complete 155 MM Howitzer, M4A1, White Bag Charge. The weight of the individual charges ranged from approximately 1 to 4 pounds; and of the completed charge, around 13½ pounds.

6 Charges were removed from the transfer chutes to the Service Hall, where they were inspected before being moved to the Assembly Room.

7 Charges were distributed in the Assembly Room to the assembly table, where they were placed in numerical order in front of each assembler, starting with Base Charge No. 3 through Charge No. 7. Base charges were placed with the igniter down and large numbers up and stacked with Charges 4, 5, 6, and 7 on top of the base in numerical ascending order - with the large number up.

8 Each pair of opposite typing straps were tied on top of the assembly with a double twist; the charge was rolled; and the straps were tightened and tied into a hard knot so that the charge was bound securely.

9 The charge was passed through the diameter and length gauge and weighed on the process scale for the correct weight of the complete charge.

10 A felt pad was placed in a paper sleeve in the protector cap, which fitted over the igniter on the base end of the charge, and was tied securely with a bow knot.

11 Charges were placed in the transfer chutes, which lead to the Packing Room.

12 Tops were removed from the M13 containers; paper linings were inserted, with an overlap of at least 4"; and fiber-board discs were inserted in the bottom of containers.

13 Charges with igniters down were placed into containers.

14 Sufficient number of wooden blocks and fibre fillers were added to take up excess space and to hold the charge firmly in place. One wooden filler with a groove was placed on top with the groove up.

15 The top was placed and tightened securely by hand and then given a ¼ to a ½ turn with a wrench.

16 After a check was made for a washer, the air test plug was inserted and tightened, and a maximum amount of three lbs. of air was inserted.

17 After a one-minute interval, an air check was made to determine whether there were container leaks.

18 The air valve was removed; another check for a washer was made; and a graphited brass plug was inserted and tightened.

19 Containers were sealed with a lead seal and put on a truck for the outgoing Service Magazine.

20 Containers were properly stenciled - indicating charge, powder lot, date, etc.

21 Loaded containers were stacked in the Service Magazine to await shipment orders.

(b) Loose Pour and Laced Method

The bags were filled according to the Loose Pour Method. The increment charges were then laced to reduce the diameter of the charge. The lacing was done with non-ferrous needles with a specified thread through corded seams provided for that purpose. The lacing at first was not very tight, but the bag was rolled and the lacing tightened until the charge was of the necessary diameter. The charge was then gauged and check-weighed. If it was satisfactory, the igniter protector caps were attached. Final inspection and packing were the next steps.

(c) Loose Pour and Wrapped Method

The bags were filled according to the previously described method. The increment charge was placed in a canvas or in a conductive-rubber cradle provided with rollers. A puttee tape extended from a roll fixed above the wrapping machine, with the end of the tape placed between the increment charge and the cradle. The rolls were tightened and the wrapping was begun. The tape was fed automatically and wrapped around the increment in much the same manner that a bandage is wrapped around an arm or leg or that a soldier wraps puttees around his legs. The tape was cut to leave an extra end, which was half the length of the increment charge. This was pulled back under the

puttee wrapping with a tool made of spring steel with an eye in the end. This tool was approximately ¼" wide and of sufficient length to slide under the wrapping.

(d) Stacked Charge Method

The stacked type of loading resulted from the need to reduce the diameter and length of the charge for large caliber guns, such as the 10", 12", 14", and 16" guns. The powder grains were stacked vertically end-on-end inside the bag by the following methods:

There was a special table with a round hole with a diameter to match the diameter of the charge. It had a flat piece of brass that closed the hole by fitting closely to the table from underneath. It was known as a slide gate. Directly under the hole in the table was a screw attachment on which was set a cylinder with a false bottom, which could be raised and lowered as needed. There was a rack with holes resembling those of a honeycomb. It was the same height as the powder grains and was called the stacking tray.

A cylinder of spring brass was made to meet the maximum height that a charge might be and still meet Government specifications. The cylinder was to be cut its full length, with holes drilled on each side of the split and with sufficient overlap to make the cylinder adjustable. This would permit loading charges of different diameter for the same calibre gun.

The following was the method used to adjust the cylinder to the correct diameter:

1 Weighed out the full amount of the complete charge and calculated the number of grains of powder in it (by weighing and counting grains in one pound to use as a guide).

2 Measured grains of powder to determine the average length of each. Divided the length of the grain into the maximum length of charge. This determined the number of layers of powder necessary for the required length of the charge.

3 Adjusted the cylinder to the proper diameter by dividing the number of layers to be used into the number of grains in the complete charge. Then placed these grains end-on-end, making a circle.

4 Gave these dimensions to the superintendent of bag manufacture for a sample bag to be made in order to make trial loading.

Detailed Loading Procedure

1 The powder was received from the hopper from the second floor on to the top of the table.

2 Grains of powder were placed into holes in the stacking tray. All holes in the stacking tray were plugged except the ones necessary to make the correct number for the desired diameter.

3 Removed stacking tray from powder, leaving powder in an upright position.

4 Brought all of the grains close together to form a circle with a leather strap of width equal to the length of the grains of powder and of sufficient length for this purpose.

5 Slid circle of powder, while leather strap was around it, over into the hole in the table onto the slide gate; then removed leather strap.

6 Pulled slide gate back, by means of hand lever, dropping the powder grains onto the false bottom of the cylinder in an upright position.

7 Closed slide gate, ready for next layer.

8 Lowered the false bottom of the cylinder with powder, by means of the screw attachment, just enough for another layer.

9 Repeated beginning with Step No. 2 through Step No. 8 until required number of layers had been put into the cylinder to give the desired weight, length, and diameter as required by the expenditure order.

10 Removed cylinder with powder from the stacking table and placed it on a small table in an upright position.

11 Took the bag and pulled it over the outside of cylinder until the bottom of bag fitted snugly over top of cylinder.

12 Then turned cylinder over, placing the end with the bag on the table.

13 Removed cylinder from the bag by holding the bottom of the cylinder and lifting straight upward. This permitted the powder to remain in the bag in layers, standing end-on-end.

14 Placed the bag on scale and checked for correct weight. It had to be handled carefully to avoid upsetting the layers of powder grains.

15 Folded the top of the bag and closed the opening with silk lacing twine of required strength. The bag had eyelets on each edge of the opening.

16 There were two flaps the full length of the charge that had to be laced in order to give proper tightness to hold the grains of powder in place. This also governed the diameter of the charge. The lacing could not be pulled too tight at first or it would not remain straight and neat.

17 The charge was then gauged for proper length and diameter.

Packing of Stacked Charges

1 Metal containers were thoroughly cleaned of rust both inside and out. If necessary, they were painted both inside and out.

2 Containers were properly stenciled according to specifications.

3 Chestnut boards were placed in bottoms of containers.

4 Containers were lined with waterproof liners, overlapping approximately six inches.

5 Brass funnels were placed in containers over paper liners in order to keep the liner in place while the charge was being inserted.

6 The igniter pad was tied to the end of the charge by straps provided for this purpose.

7 Placed protector caps over the end of charge to which the igniter pad was tied to protect the igniter from jar. The knot was tied securely.

8 Inserted charge into the container through funnel.

9 Removed funnel.

10 Placed a chestnut board disc over the top of the charge; then filled the remainder of space with dry wooden blocks.

11 Checked for rubber gasket in correct place. Then placed the top on the container and saw that the spider prongs were securely in place.

12 Tightened top hand tight. Then gave top $\frac{1}{4}$-to-$\frac{1}{2}$ turn with a wrench.

13 Removed brass plug from top and inserted air plug. Then inserted from 3-to-5 pounds of air into containers, according to the amount shown in specifications; the container was under pressure for the time specified.

14 Removed air plug, and if container had not leaked, placed a mixture of graphite and grease on the threads of the brass plug and screwed it into the hole after inserting a small leather washer to make container air tight.

15 Placed lead seal on top of container according to specification. This was sealed by means of a Government sealer.

The charges were now ready for shipment.

(6) Powder Lot Changes - Smokeless Powder

Prior to the completion of a lot which was in process, line foremen anticipated the exact use of bags on hand by comparing the number of bags with the amount of powder remaining unloaded. This was determined by checking the powder remaining in the hoppers and adding to this the amount of powder in unassembled charges. This total weight was divided by weight of a complete charge to determine the number of different zones needed to complete

the lot. Inventory was now made of unfilled increment bags, and re-run was placed with the Sewing Room if necessary. This check was made in sufficient time to avoid stoppage of operations.

Details of the Powder Lot Change Procedure were as follows:

1 The shift supervisor would learn from the control record of charges manufactured approximately when the lot would be completed. If the change was perdicted during either of the night shifts, the day shift would make a general check of powder and materials and place orders for bags, etc. Ample time was given for bag completion.

2 When it was time for the check to be made, the line foremen were contacted to instruct powder men to dump small quantities of powder in the hopper thirty minutes in advance. This made it easier to measure the powder which piled up in the hoppers.

3 Stock foremen were instructed to make actual physical count of all material, issued or unissued, on the line.

4 Assembly men counted all unassembled zones. House foremen expedited this check by detailing extra men to clean Assembly and Packing rooms of charges prior to the check. When the count had been made, the number of increments for each zone was recorded and all increments coming through chutes were added until the lot was finished.

5 Government inspectors were asked to count the remaining data tags and identification plates in order for the two to compare in the final check.

6 Line foremen with two powder men would measure the powder in tubs and containers in the following order: Loading booths; Elevator Room; Hopper Room; Rest House; and Incoming Magazine. Containers were checked as follows:

Carpenter	- 28" deep	5 lbs. per inch
Navy	- 25" deep	5 lbs. per inch
Copper Tubs	- 14" deep	10 lbs. per inch
Copper Tubs	- 7" deep	10 lbs. per inch

Before arriving at a final figure, the supervisor had to concur with the magazine foreman that all powder of that lot was in the Line Magazine.

7 A computation was made of the inventory figures, and an order was placed with the Bag Manufacturing Department for bags needed to complete a lot, allowing a few extra bags for rejects.

8 The time of the powder lot change was estimated, and the following were notified of the time and new powder lot: Scale, Bag Manufacturing, Printing, Magazine Area, senior Government inspector, and Hercules inspector.

9 As a lot was finished, all extra material was returned to the Warehouse. Tubs were wiped, hopper stoppers pulled, and booths were cleaned.

10 Magazine Area foremen were notified to relieve the Line Magazine of packed charges and empty powder cans. Attention was then given to obtaining material for the new lot.

(7) Process Inspection

During Loading Operations, it was necessary for bags to be inspected for proper seams with no loose ends and for proper markings that were clearly showing on the bags.

In general, the following factors were considered in Bag Loading Inspection:

1 Saw that there was no improper stitching.

2 Made sure that the stitching was not more than ½" from the edge of the cloth and not less than ¼", with a tolerance of 1/8".

3 Made sure that the zone and lot numbers were not obscured by holes in the cloth.

4 Made sure that the printing was readable.

5 Saw that the seams over the powder holes were closed properly.

6 Noted any defects in weaving.

7 Gauged bag for maximum and minimum length and diameter.

8 Containers were checked for packing to determine that no damage or fault existed whereby air or moisture could come in contact with the powder.

9 Saw that end plates were properly stencilled for correct lot.

10 Aluminum identification plates were checked for correct lot number and ballistic data.

11 Finally, checked package for proper packing and absence of any loose play that would cause package to become damaged in transit.

Process inspectors were on the lines and inspected the material as it was assembled and packed.

After the charges were loaded and assembled, they were gauged in diameter and length to insure the final dimensions to be within the limits prescribed in the specifications. On account of the human error involved in weighing powder for the charges, each charge was check-weighed by an independent operator. Igniter charges were often measured by volumetric weighing, and to insure the accuracy of the weights of these charges, every tenth charge was check-weighed on an analytical balance or its equivalent.

c. Loading Igniter Charges

(1) Black Powder

Propellant charges of all types required an igniter charge of black powder to be sewed to the base end of the charge. This black powder had to be of a certain chemical composition, grain size, and moisture content to meet Government specifications.

Black powder is of two general compositions; namely, that composed of potassium nitrate, charcoal, and sulphur and that composed of sodium nitrate, charcoal, and sulphur. The potassium nitrate composition was used in all military powders except in the igniters for saluting ammunition.

Black powder is hygroscopic and required drying before use as igniters unless the moisture content was five tenths of one per cent or less. If drying was required, the powder was first screened to secure sizes required by the specifications. It was then placed on trays, with twenty-five pounds on each tray. The trays were all copper with a fine copper-wire bottom. The trays were then placed in an enclosed cabinet in the Powder Room, where air, at a temperature of 150 degrees Fahrenheit, was circulated from 4-to-6 hours to bring the moisture down to the requirements of the specifications.

The grades of black powder are classified according to the size of grains that will pass through wire screens of a designated number of meshes per inch. The following table from Specifications 50-14-1B of June 12, 1934, shows the various sizes as screened:

Grade	Size No.	Passer Screen	Duster Screen	Production Per 8 Hours
A	1	4	8	2400 lbs.
A	3	12	16	2400 lbs.
A	4	16	40	1500 lbs.
A	5	40	100	1500 lbs.
A	6	100	140	1500 lbs.

Grade A1 Powder is that which will pass through a U. S. Standard Number 4 Screen but will remain on a Number 8 Screen.

Grade A1 Powder is prescribed for igniters used in the 155 MM Howitzers, 155 MM Guns, and 8-inch to include 16-inch guns.

Since black powder is very sensitive to jars and friction, great care must be exercised at all times in its handling. A large red figure "4" was painted on the outside of all Operating buildings and Service Magazines where black powder was handled to designate the presence of a dangerous explosive.

(2) Building Facilities

Each Operating Building was composed of individual rooms with one operator in each. They were known as Hopper rooms, Loading rooms

(volumetric machine), Sewing Machine rooms, and Inspection and Packing rooms. Safety transfer chutes led from each room. This was a safety precaution for the operators.

The Service Magazines were located at distances from the Operating buildings according to the "Distance Table" in the Ordnance Safety Manual. The distances were those required for the maximum amount of powder to be on hand at one time.

(3) Loading Procedure

Black powder was transferred from the Magazine to a Rest House, which was usually located approximately halfway between the Service Magazines and the Operating buildings, in small quantities of 1 to 2 cans (25-lb. cans) per trip.

The lid of the powder container was loosened with a wrench and removed by hand. Cans were then carried to the Hopper rooms and dumped into hoppers, the powder traveling by gravity through a copper tube into a volumetric machine in the Loading Room.

The volumetric machine could be adjusted to load igniters of different sizes and types, the volume varying according to the type of gun in which the igniter would be used. The setting of the volumetric machine was always checked by emptying the full charge into a weigh cup and by weighing the charge on the scale to see that the setting would volume the required weight of powder, as called for in the specifications. When the machines were correctly set, the operators loaded igniter bags volumetrically and check-weighed every tenth charge. The purpose in check-weighing every tenth charge was to keep the volumetric machine set correctly for accurate loading.

Several things had to be considered by the volumetric machine operators in order to get uniform results. The speed with which the handle was moved was most important. Instruments could not be struck too hard with the handle; smooth movements produced the best results.

The two methods of loading the measured powder into igniter bags (pads) were pour loading and blow loading.

In pour loading, a funnel was attached to the outlet of the volumetric machine; the igniter bag was placed on the funnel; and the black powder was then dropped from the machine into the bag.

The Blow Loading Method was used only in loading quilted igniter bags (pads) and charges carrying two igniter pads with a core through the center of the charge leading from one igniter pad on one end of the base charge to the igniter pad on the other end. A copper tube with an air attachment fitted into the quilted igniter pad and core.

The powder was blown through this tube into the igniter pad and core with air pressure of about fifteen pounds.

After loading, the igniter bags were passed into a Sewing Room through a safety chute, where another operator sewed up the opening. The openings in the igniter bags were kept closed by clamps while they were being transferred from the Loading Room to the Sewing Room. The clamps were removed before the openings were closed by the sewing machine operators. Phosphorbronze needles were used, and each bag was double-stitched to prevent any powder from leaking.

The bags were then inspected for workmanship and weight. Igniter charges weighing less than 8 ounces were allowed a tolerance of plus or minus 0.10 ounces. If they contained over 8 ounces, a tolerance of plus or minus 0.20 ounces was allowed. Bags were then packed into boxes or containers and made air tight. They were then ready for transfer to the Smokeless Loading lines for final assembly with the smokeless-powder charges.

d. Scale Shop

The Scale Shop was maintained for the purpose of repairing scales, sewing machines, and other line equipment; and for building check weights and weight cups.

The work of the Scale Shop was as follows:

(1) Received and handled Job Orders; stated size of charge to be loaded, with correct weight of each charge.

(2) Checked Job Orders against Expenditure Orders for accuracy.

(3) Shop mechanics built check weights for each zone of the charge in the following manner:

(a) Brass stock of desired length was cut on a screw cutting lathe of 9" swing and 4-1/2 ft. base.

(b) A hole was bored in one end that was deep enough to add lead shot to bring the check weight to within ten grains of desired weight.

(c) Lot number, zone number, and weight were stamped on the brass cap which was soldered onto weight.

(d) Weights were then checked on master scale to 1/1750 of 1 ounce, and any difference was corrected with a piece of emery cloth.

(e) The Government inspector verified each weight. Each weight was approved before being assigned to the lines for loading.

(4) When the lot was completed, all check weights were picked up and brought back to the Scale Shop, at which time immediate removal was made of the lot number and weight figures. This prevented mix-up of lot numbers or weights.

(5) Scales of different size and type were prepared for the various lines according to the different types of charges loaded on that line. Scales were returned to the Shop for repair. They were repaired in the following manner:

(a) The front platter, case from scale base, and the front and rear outriders were removed.

(b) The dash pot plunger from the scale lever was disengaged.

(c) The lower end of the flex spring was loosened and pushed back, and the abutment plates were removed from the center yoke.

(d) The lever was lifted out of a gate bearing, and the pivots were checked for rough edges or chipped places.

(e) The pivot alignment was checked, and pivots were honed to a razor edge with fine stone.

(f) The bearings were checked for cracks and alignment.

(g) The dash pot was checked, cleaned, and refilled with new oil.

(h) After thorough checking and cleaning was completed, the scale was ready for re-assembly. The lever was replaced and the flex spring and the dash pot plunger rehooked. The abutment plate in the center yoke, the front and rear riders, and the front platter were then replaced in order named. Flex springs were set to the desired tension according to the sensitivity of the scale. Then with weights, the scale was checked to its capacity. If checks were accurate, the front platter was removed and the case replaced. Then the front platter was again replaced.

(i) A final check was made and if correct, the scale was put in stock until needed on the line.

(6) Aluminum or copper cups were calibrated and stamped according to the size charge to be weighed. This was necessary because of the use of a Shadowgraph Zero Reading Scale, since the weight had been built up inside to represent the weight of the cup against the cup content weight, thereby affording the correct weighing of the charge.

(7) Sewing machines were repaired and adjusted by experienced

mechanics. All parts were purchased from manufacturing companies. All of the sewing machines were made by the Singer Sewing Machine Company. They were special machines made for explosive work. The New River Plant mechanics added improvements to the machines, such as individual bobbin winders and special thread cutters.

The New River scale mechanics added the following improvements to the scales, which improvements were adopted for use by other plants:

(a) Extra mirrors added to the scales for the use of operators who must sit as they weigh.

(b) Extra openings made in the scale case which allowed light bulbs to be changed without removing scale cases.

The Scale Shop used the following equipment: power buffer, drill press, emery wheel, vise, blow torch, acetylene torch, set of metal number and letter stencils, complete set of small hand tools, carborundum finishing stones, complete set of lathe tools, and set of drill press tools.

5. Safety Precautions

a. Equipment, Clothing, and Practices

All equipment in the Powder lines was grounded to drain static electricity. All of the floors in the Black Powder and Smokeless Powder buildings were made of hubbelite, which carried the static electricity from operators to a ground wire. Safety shoes were made of conductive materials for this purpose.

The rooms in the Explosive buildings were separated with explosive or fireproof walls which were 10 to 12 inches thick and made of steel reinforced concrete.

Tables, transfer chutes, sewing-machine needles, and all pieces of

equipment were made from non-sparkling metals. Bronze, brass, copper, and aluminum were the non-ferrous materials which will not produce sparks.

Fireproof safety coveralls were worn by all operators in the Powder buildings. Operators working in black powder during Screening, Drying, and Igniter Loading were required to wear safety clothing, the change being made in the regular Change Houses. On these lines the rooms were washed and scoured at the close of the shift to eliminate collection of powder dust.

In each room instructions were posted, showing the number of operators and transients permitted at any one time. The limit was set according to the type of room and the type and amount of powder which was present at any one time. This referred to the maximum amount of powder which allowed operation to proceed efficiently without unnecessary exposure.

Standard rules for safety procedure were stressed at all times. A certain number of operators from each building were periodically selected to be present at safety meetings. These meetings were conducted expressly for the purpose of acquainting the operators with the plants' interest in safety, and of stimulating their desire to participate, to the extent that they were able, in making useful and practical suggestions in that part of the work in which they were most familiar. The employees participating in these weekly meetings included those from the Scale Division, Warehouse Section. Bag Loading lines, and Igloo Area, as well as the powder truck drivers.

As a measure of safety and cleanliness, janitors were stationed on all lines of this department. They were responsible for maintaining neat appearance of toilets, Canteens, and anterooms on the lines, being directly responsible to the explosive foremen. They were required to keep close watch on general appearances of the buildings, including all fixtures, floors, tables, desks, benches, etc., and would at no time permit the piling up of loose scrap or waste within the buildings.

.07 was allowed for the complete charge of a 105 MM Howitzer, with a plus or minus .01 allowed for each zone. The tolerance varied for each type of charge and was set by the Ordnance Department.

7. New River Stops Production

On May 24, 1943, in accordance with instructions from the Ordnance Department and confirmed in writing as of that date, which formal confirmation was embodied in Supplement No. 6, dated January 25, 1944, the Bag Loading Operations ceased, and action was started immediately to put the Production Units of the plant in standby condition. The Storage Magazines were operated from May 25, 1943, to September 19, 1943, as an Ammunition Storage Depot.

During the period from May 25, 1943, to September 18, 1943, inclusive, several hundred employees remained on the New River payroll putting the Production Units of the plant in standby condition.

When production ceased at New River, some of the Hercules key men were reassigned as follows:

To Port Ewen, N. Y. (11): Messrs. John Glover, Charles Seadek, Arthur Scheff, Hunter Hunkle, P. C. Furbeck, James W. Dugan, A. J. P. Seitz, C. D. Baker, W. J. Joyner, John F. Schappel, and J. J. Tossi.

To Radford Ordnance Works (4): Messrs. J. T. Sydnor, N. H. Hurd, E. V. Kenney, and Jay Harned.

Prior to production stoppage, the War Manpower Commission had notified Holston Ordnance Works, Kingsport, Tennessee; Triumph Explosives Company, Elkton, Maryland; du Pont Works, Richmond, Virginia; and the Celanese Plant, Narrows, Virginia, of the experienced workers that would be released. Representatives of these companies came to interview employees. The employees were given opportunity to accept jobs without loss of time. A number accepted employment.

Effective at 12:01 A. M. September 19, 1943, the status of the New River Ordnance Plant operating as an independent plant was changed to make it a unit

of the Radford Ordnance Works under Contract W-ORD-462.

8. Production and Personnel Statistics to May 25, 1943

Monthly production and personnel statistics, from the date that production started in September, 1941, through the date that production ceased on May 24, 1943, will be found at the end of this chapter.

9. Work during Standby Period

The Operating Force thoroughly cleaned all Loading Line buildings after production had been discontinued. This work was completed within a few days after the shutdown order was received, and all employees of the Bag Loading Department were terminated or transferred to other Hercules plants.

The Maintenance Department retained a sufficient number of men to check, clean, and grease equipment; and to place it in a standby condition. Approximately thirty days after this work had started, additional orders came to remove and crate all equipment. It was shipped to other Ordnance plants in various states. This included hospital, cafeteria, and all production equipment except enough maintenance material to keep trucks and the Magazine Area in operating condition.

The Magazine Area continued to store surplus powder that was shipped from other plants and reshipped powder as orders were received. This work continued under the New River Ordnance Plant Management until September 19, 1943. At that time the records were closed, and the Magazine Area went under the direction of Radford Ordnance Works.

10. Trench-mortar Increment Packaging

a. Introduction

Propellant powder for trench mortars was produced in the form of increments. Each increment consisted of a number of sheets of rolled powder sewed together in the form of a small book. Increments were assembled onto the base or fins of the trench-mortar shell before the shell was shipped to the

fighting front. Shells were shipped in cardboard containers impregnated with asphalt, and, as a result, were partially protected from the elements. However, on long storage in the South Pacific Area, there was considerable moisture vapor transfer through the cardboard container, with the result that the propellant powder absorbed appreciable amounts of moisture; consequently, the performance of the ammunition was adversely affected. After the ammunition was received at the fighting point, it was removed from the cardboard containers and stacked conveniently around the mortar in which it was to be fired. In this form the powder was completely exposed to the elements, and in case of rain or snow, it would become very wet. This caused considerable difficulty on both the South Pacific and European fronts.

The Ordnance Department investigated means of protecting the propellant charge from the elements by inclosing each powder increment in a moisture-proof bag. Various packaging materials were tried but none were entirely successful. The best material found by the Ordnance Department was Saran-coated Cellophane. This was developed and produced by the Sylvania Industrial Company solely for use in packaging trench-mortar increments. The Ordnance Department investigated sources of bags made of this cellophane as well as means of sealing the bags after insertion of the trench-mortar increment. They recommended that bags manufactured by the Ivers-Lee Company of Newark, New Jersey, be used and that "Wrapade" crimpers be used for sealing the bags.

At this point the packaging problem was turned over to Hercules Powder Company with a contract for the installation of necessary equipment for packaging 400,000 increments daily. Hercules Engineering departments at Wilmington and Radford, together with the Operating Department, investigated the problem. Safety considerations made some changes in the "Wrapade" Crimper necessary. Other changes were authorized because of the inability to obtain certain parts for these crimpers. No suitable location was available at the Radford Plant for this operation, but the Loading buildings at New River Ordnance Plant

seemed fairly well adapted, and as New River was not operating at the time, Line 4 was selected and converted to increment packaging. Equipment was installed in Loading Buildings "A" and "B" for the Packaging Operation. The Igniter Magazines were used for packing. The middle Magazine was converted to a Powder-conditioning Building by the installation of air-conditioning equipment. Since conditioning of the powder was not found to be necessary, this building was used for storage of non-explosive materials and for box preparation. The other two Magazines were used for incoming and outgoing powder.

Considerable attention was paid to the safety of the operation. Powder and personnel limits were set very low to minimize the possibility of a serious accident.

At the time these facilities were installed, the Ivers-Lee Company was engaged in the development of an automatic packaging machine which they believed could be adapted to the packaging of trench-mortar increments. Two of these machines were purchased for trial, and later more were purchased so that eventually all the Packaging Operations at New River were carried out with these machines.

A procedure for the salvaging of under-weight increments was developed, and the necessary facilities for carrying out this operation were installed at New River.

b. Resumé of Operation

Increment Packaging Operations at New River Ordnance Plant began in November, 1943. This operation was part of the Smokeless Powder Department at Radford and was under the supervision of the smokeless powder superintendent. Mr. J. T. Syndor was area supervisor of the operation. The smokeless technical assistant and smokeless chemical engineers aided in both the technical problems and the supervisory problems encountered in this operation. After a brief training period with dummy powder, actual packaging of trench-mortar increments was started on November 13, 1943. Originally only M3 increments for the 60 MM

Trench Mortar were packaged; later, M1, M2, and M2A1 increments for the 81 MM Trench Mortar were packaged.

At the start of the operations, each cellophane bag or envelope was opened, and the powder increment was inserted by hand. This process was extremely slow. Poor quality resulted from straining and tearing the bags when the increments were inserted. The Radford Maintenance Department designed and built a simple machine for performing this operation. Powder increments were stacked in a vertical magazine, and a foot-operated plunger pushed the increment from the magazine into the cellophane bag. This left both of the operator's hands free for opening the bags and handling the packaged increments. At the start, this increased the number of increments an operator could bag from a range of 10 to 16 per minute to 25 to 50 per minute. After operators gained skill with the stuffing machine, much better efficiency was obtained. Maximum efficiency was usually not obtained until an operator had from nine months-to-a-year's experience with this machine. A major improvement in the quality of the packaged increment was obtained by the use of the stuffing machine.

Some modifications of the crimper were necessary to improve efficiency of the operation and the quality of the product. The crimpers were equipped with a clutch so that they would normally be stopped between the crimping of each bag. By the installation of a false top on the crimper so that the increments would be at the same level as the slot in the feed plate, it was much easier for the operators to insert the bags into the crimper, thus permitting the machine to run continuously. This not only increased the efficiency of the operation but also reduced the number of bags which were pleated and wrinkled by the crimper. Before satisfactory operation of the crimper was obtained, it was necessary to realign the crimper jaws and in some cases "lap" the jaws together for better fitting. Eventually stainless steel was found to be a more satisfactory material for the crimping jaws than the bronze which was originally furnished; hence all jaws were changed to the stainless-steel type. The crimping

jaws were heated electrically, and the heat was controlled by means of rheostats. The actual temperature of the jaws was determined at frequent intervals by means of a thermocouple and potentiometer.

After packaging, it was necessary to inspect each packaged increment to be sure that the bag was properly sealed. It was necessary to install fluorescent lights in order that the operator might readily see the various defects. What constituted a defect was not always clearly defined, and therefore the elimination of the defects depended to a considerable extent on the operators. When considerable difficulty with the quality was encountered, the inspection was very rigid. At other times only the more easily seen defects, such as string or powder in the seal of the bag or unsealed bags, were removed.

Because of the small amount of powder permitted at each operation, the servicing of the operation required a considerable number of operators. Since this part of the operation greatly influenced the efficiency of the entire operation, it was given constant supervision to insure a steady flow of material to and from the various operations.

After the operation was well established, the supply of cellophane bags was found entirely inadequate. The Ivers-Lee Company adapted other machines to the manufacture of the cellophane bags, and other suppliers of the bags were found. When adequate manufacturing facilities for the bags were developed, a shortage of Saran-coated Cellophane was encountered. This was overcome by increased facilities for the manufacture of Saran-coated Cellophane and by the use of a du Pont Nitrocellulose-coated Cellophane. The first automatic packaging machine supplied by the Ivers-Lee Company was installed and put into operation in October of 1944. The second machine followed shortly thereafter. These machines were a modification of a pill-packaging machine which Ivers-Lee had supplied to the Miles Laboratory. They were put into operation with very little difficulty and performed well right from the start. The use of these machines more than doubled the efficiency of the Packaging Operation. The most notable change, how-

ever, was the very great improvement in the quality of the packaged powder. Certain difficulties with these machines were encountered. Considerable experience was required on the part of the maintenance men before they could make the necessary adjustments without loss of time. Temperature controllers were installed in these machines. These were a great help in assuring the proper sealing temperature at all times. The quality of the operators required by the automatic machines was not appreciably different from that of the hand operation. Fewer people were required because 2 machine operators could accomplish about the same as 10 people stuffing and crimping by hand. The servicing and inspection were both much easier when using the automatic machines. Additional machines were purchased, and before the New River Plant was shut down, four of these machines had been in operation for several months. This permitted catching up on all of the backlog of powder.

Considerable ammunition was in the South Pacific Area in an unuseable condition because of moisture absorption by the powder. The New River Ordnance Plant was requested to prepare "replacement" rounds for this ammunition. A "replacement" round consisted of sufficient increments for one full charge, all sealed into one long cellophane envelope. A number of these envelopes were placed in an asphalt-paper-foil envelope, which was then sealed. This was then put in a regular ammunition container. The loading of these rounds necessitated considerable changes in handling and inspection. This order was completed in a very short time after receipt of the necessary materials. There were no repeat orders. A considerable quantity of M2 increments for the 81 MM Mortar were packaged. This package was similar to that for the "replacement" round, except that there was only one cellophane envelope in each asphalt-paper-foil envelope. Packaging of this increment was stopped by the production of the M2A1 Increment, which replaced the M-2 increments.

During those periods, when insufficient work was at hand to keep the operators busy - that is, when there was a shortage of powder or cellophane

envelopes - the operators were put to dethreading rejected increments. These increments had broken or torn flakes, were poorly sewn, or were otherwise imperfect. The Dethreading Operation consisted of removing the stitching from the increments so that the powder could be recovered by re-rolling at Radford. The efficiency of this operation was never very high.

Maintenance was never a serious problem on the Increment Packaging Line. During most of the period of its operation, there was one mechanic assigned to this work on each shift. He was able to take care of all repairs except those that required Machine Shop work. After nine-months-to-a year's operation, the cams of the "Wrapade" crimpers became worn and had to be built up and re-machined. With the use of the automatic packaging machines, there was considerable shop work involved in sharpening the knives in the cut-off rolls and in re-machining the crimping rolls. The policy of having each automatic machine shut down once a week sufficiently long for a mechanic to make a thorough inspection and to make any needed adjustments or repairs resulted in a decrease in the amount of maintenance work necessary on these machines and in a considerable increase in the production per machine.

The facilities at New River were not adequate to meet the production requirements scheduled for the latter part of 1945 and the first part of 1946. In addition, loading schedules were so high that the buildings of Line 4 were required for bag loading. Accordingly, a new Packaging Line was designed and built at Radford Ordnance Works. Before this was completed, it was necessary for the Packaging Operation to move out of "A" Side of Line 4. The Salvage Operation was moved to temporary buildings in the Roller Powder Area at Radford Ordnance Works. The Hand Packaging Operations were moved to No. 2 Igniter Line at New River Ordnance Plant. When Packaging Operations were started at Radford, the Hand Operations on the Igniter Line were stopped. By July 16, 1945, Radford was packaging sufficient powder to permit Packaging Operations at New River to be dropped to one shift. All operations were stopped on August 18, 1945.

c. Increment Salvage

In the production of rolled-powder increments, a considerable number of "reject" increments were obtained. Some of these were perfect increments except that they were underweight, that is, below the minimum weight allowable. It was customary either to dethread these increments and re-roll the powder or to sew additional flakes of powder onto the increment. Neither procedure was economical, but because of the critical shortage of raw materials, some method of salvage was necessary. Some of the rejects were merely poorly sewed. There was insufficient stitching in the increment to prevent loss of powder flakes in packing and loading.

It was obvious that if the powder were sealed in a cellophane bag there could be no loss of powder even if no stitching were present. Therefore, increments with loose flakes could be used if they were inserted into the bag without loss of powder.

Tests by the smokeless chemical engineers at Radford indicated that an economical procedure for this could be worked out. The Packing Room of 4A Loading Building at New River was altered, and fourteen Shadowgraph scales were installed. The salvageable increments were shipped from Radford to New River and each increment weighed. The operator adjusted the weight by inserting loose flakes of powder in the increment or by tearing off flakes if the increment were overweight. The weighed increments were inserted in the stuffing machine and bagged in the same manner as other hand-packaged increments.

The quality of the finished product was approximately equal to that of the regular hand-bagged powder. All lots of powder were well within weight specifications. The tightness of the package was governed by the quality of the cellophane bags available and was subject to the same variations as the regular hand-bagged increments.

There was considerable difficulty in obtaining a reasonably high efficiency in the weighing. This efficiency was increased by stressing the importance of

the work to the operators, by informing the operators of the production expected of each of them, and by creating friendly rivalry between the operators and between shifts. Close supervision was necessary.

The cost of increment salvage was less than the labor cost of making new powder and considerably below the cost of dethreading and reworking the increment. Since this operation resulted in a considerable decrease in the amount of rework at Radford, the total powder available to the armed forces was increased by the amount of powder salvaged. For several months Radford was able to meet the schedules requested by the Ordnance Department only because of the added production resulting from the Salvage Operation.

d. Quality

At the time the Increment Packaging Facilities were installed, no specifications covering the packaged powder had been prepared. Tentative specifications were set up at a conference at Radford just as operations were being started. A vacuum test to check the tightness of the package was set up. In addition, it was determined that all packaged increments must be given a visual examination to sort out defective seals. The Ordnance Department made a visual examination of a sample taken from each lot.

To insure maximum quality at all times, a checking system was set up on the line. Qualified operators were selected and assigned full time to the checking. The checking consisted of the following:

(1) A vacuum test from each crimper.

(2) A temperature check of each crimper.

(3) An examination of the stuffed increments from each stuffer.

(Each of the above checks were made on a regular time schedule.)

(4) The work of each inspector was checked each time she sent a tray of powder into the service lane for packing.

(5) Visual examination.

(6) Weight check.

(7) Vacuum test.

As far as possible, the identity of each operator's work was kept throughout the process so that in case of poor quality, the operator or equipment responsible would be known.

The quality of the final product was dependent upon the quality of the cellophane bags supplied. Many of the bags which appeared to be satisfactory were actually weak and would break open after packing. In addition, in dry weather the cellophane became brittle, and packages which were satisfactory when they left the line were broken open when examined at a later date. In moist weather the cellophane became sticky, and the packages would stick together after packing. After the development of an immersion test, it was discovered that a great many seemingly tight packages would admit water after a few hours immersion.

The envelope suppliers all complained of the difficulty in fabricating envelopes of satisfactory quality from Saran-coated Cellophane.

Because of the difficulties in the use of Saran-coated Cellophane and the inadequate supply of it, an investigation of available materials was made. Du Pont 450 Gauge MSAT No. 84 Cellophane appeared to be satisfactory and was available. Authorization to use this type for half of the requirements was received in October, 1944. This proved to be much better in respect to strength of seal, resistance to immersion, uniformity, handling, etc.; it was not quite as good on moisture-vapor permeability.

The use of this material greatly improved the quality of the packaged increments when hand-packaging and when using the automatic machines.

In most cases when lots of packaged powder failed to meet the specification requirements, they were accepted on waivers. In a few cases where there were indications of poor supervision on the part of Hercules Powder Company, the lots were withdrawn and reinspected. The reinspection at best resulted in only slight improvement. Most of the lots reinspected were later accepted on waivers.

The Ordnance Department, particularly the Inspection and the P&E divisions, worked very closely with Hercules Powder Company representatives. Those divisions were kept informed as to the difficulties encountered, and wherever possible, altered specifications or granted waivers so that lots would not be rejected through no fault of Hercules Powder Company.

e. Production Efficiency

The production rate and efficiency varied greatly. During the first year of operation, there was a chronic shortage of cellophane bags. An adequate supply of bags was always promised so, as the packaged powder was urgently needed, an excess of personnel was normal. Many "changeovers" in the type of powder being packaged were necessitated by shortage of the right type of bag or powder. This all contributed to poor efficiency.

An adequate supply of cellophane bags was received about the same time the first automatic machine was placed in operation. After this time, the operations were kept in close adjustment with the production of powder at Radford to reduce as far as possible the "changeovers" necessary. Efficiency on all operations increased rapidly and continued to increase until the operation was stopped.

f. Personnel

Except for the very few men required for hand-trucking and packing, female operators were used exclusively. These were under the supervision of a line foreman and house and area foreladies. The majority of the personnel were of an exceptionally high type and maintained a great interest in both quality and quantity of output. Nevertheless, absenteeism was always a problem.

The personnel assigned to the operation fluctuated widely with the supply of powder, bags, and the type of operation. Thus, with a big backlog of powder, a fair supply of bags, and emphasis on the Salvage Operation, the personnel was increased during the fall of 1944. Early in 1945 a reduced schedule necessitated a personnel reduction. The installation of more automatic machines caused a

further reduction in spite of an increased schedule. The transfer of the Salvage Operation to Radford caused a further reduction.

When reduction in force was necessary, it was usually possible to transfer operators to other operations at New River. When the new line was started up at Radford, a considerable number of experienced operators were transferred to Radford.

g. Safety

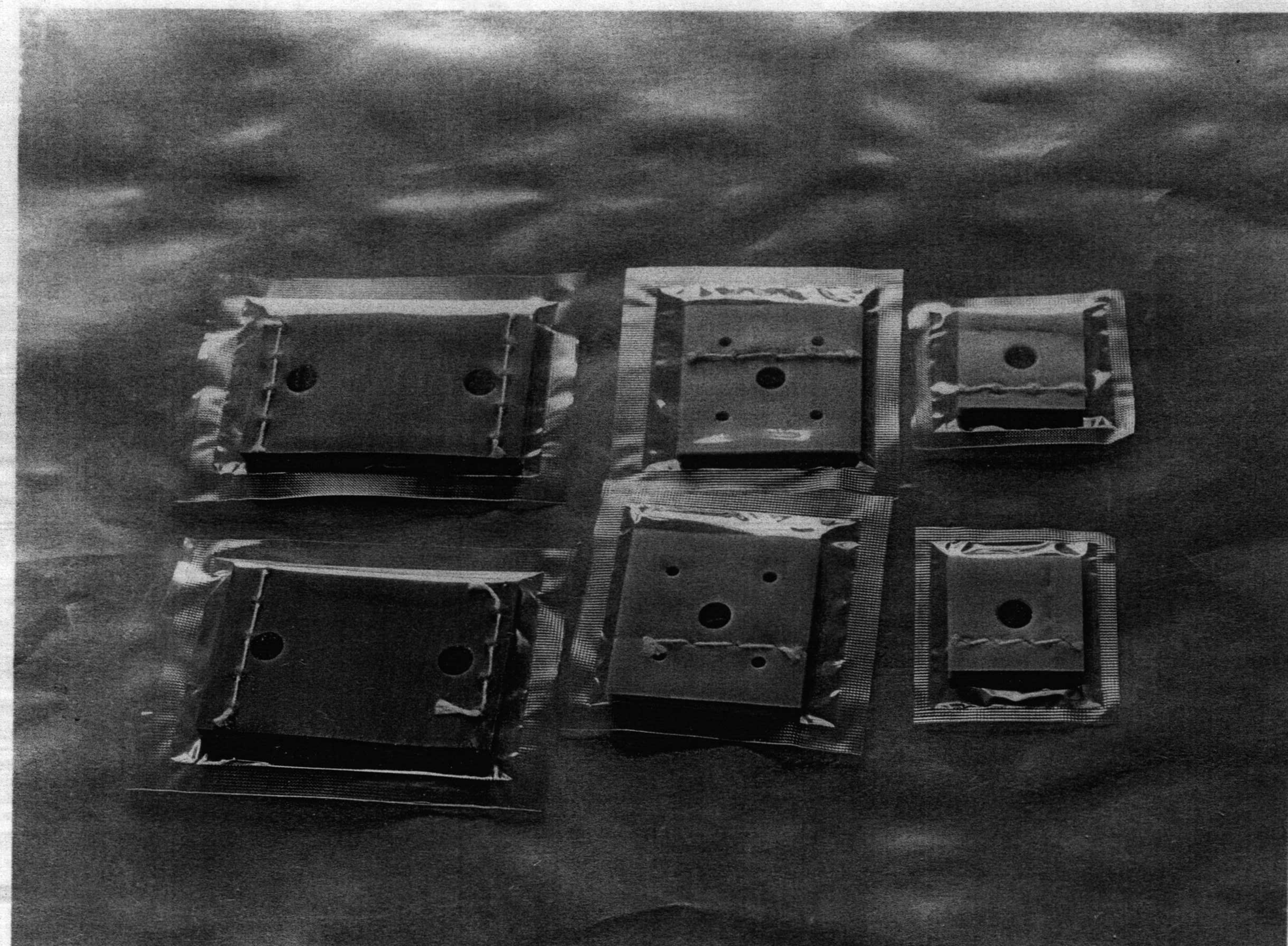
The Packaging Line was originally set up with very small powder and personnel limits. Some of these were modified slightly as required by the operation.

Because of the low limits and the large amount of handling involved, the limits were exceeded frequently. This was not necessary, but it seemed impossible to convince the operators of the importance of staying under the posted limits. Some improvement in this condition was made throughout the history of the operation.

With the automatic machines, higher powder limits were required but more attention was paid to mechanical protection of the operators and to the establishment of safe operating rules. There were four fires on the automatic machines but without any personal injuries resulting.

Minor injuries were limited to the normal number of pinched fingers, scratches, bruises, etc., that seem inevitable whenever material is being handled. The wooden powder boxes, steel straps around the boxes, and the doors to the service chutes were the most common sources of these injuries. In the majority of cases, they were due to inattention on the part of the operators.

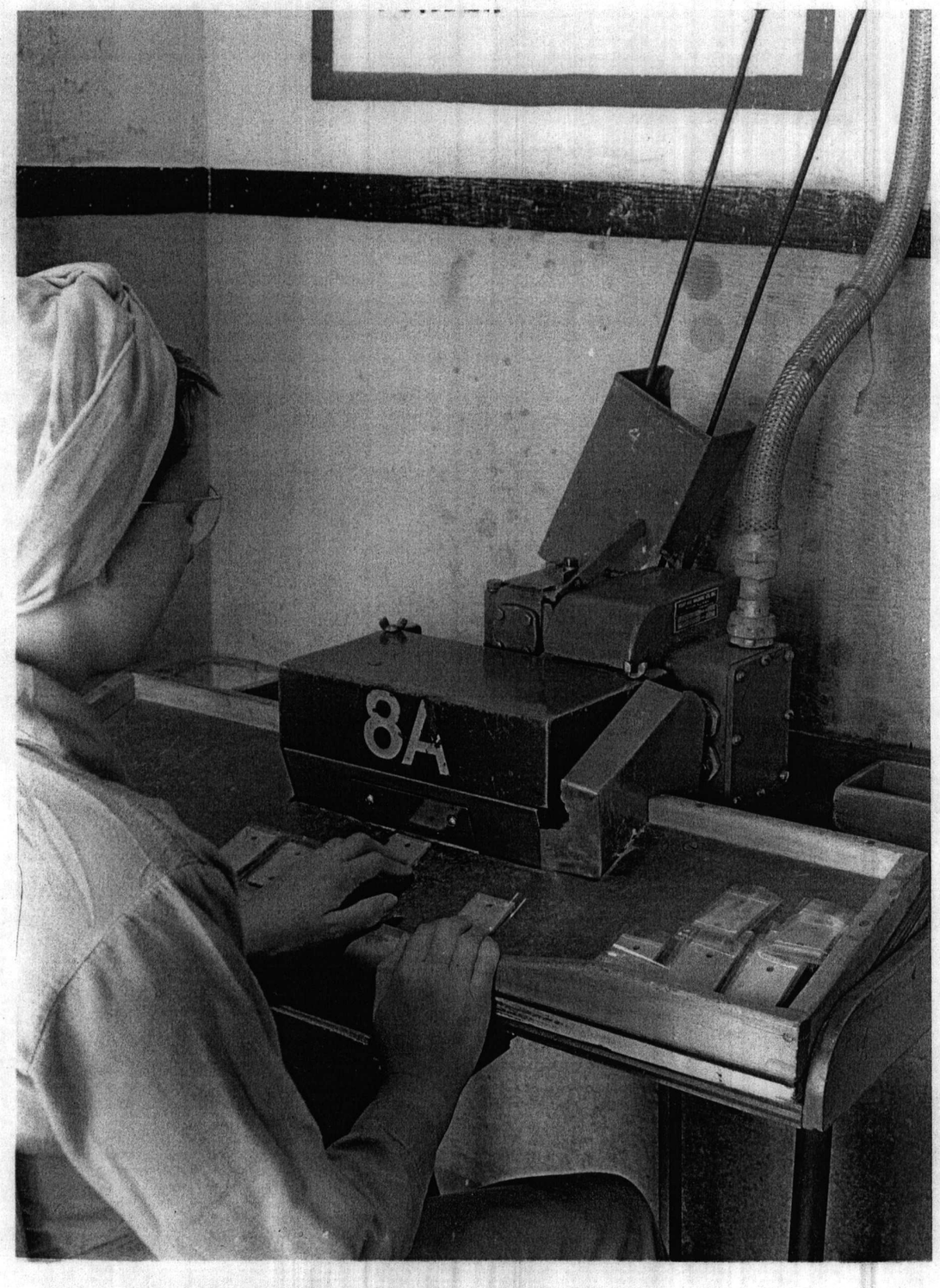
One lost-time injury occurred when an operator allowed a hand truck to get out of control, and a box of powder fell on his foot. A second injury occurred when an operator fell on an icy road between the line and the Change House.



CELLOPHANE-WRAPPED TRENCH-MORTAR INCREMENTS

NR-15

HAND-OPERATED CELLOPHANE ENVELOPE STUFFING MACHINE NR-11



"WRAPADE" CRIMPER USED TO SEAL CELLOPHANE ENVELOPES NR-12

11. Flash Reducer Developments and Production

a. Introduction

In World War II it was found that during the invasions in North Africa, Sicily, and Italy there was an urgent need for the 155 MM Gun, M1 because of its accuracy and effectiveness. The flash of these guns, when fired at night, permitted the enemy to plot the gun locations.

The Ordnance Department had done some development work after World War I looking toward eliminating the muzzle flash, but it was not carried to a conclusion.

Mr. W. S. McGilvray of the Technical Division, Army Ordnance, Washington, D. C., was assigned the duty of developing a means of eliminating the flash of guns when fired. His study began in 1942, and for months experiments were made without good results. In 1943, a formula was found which began to effect better performance.

By the early part of 1944, Mr. McGilvray had developed a flash-reducer charge that could be fastened around the propelling charge; from a laboratory standpoint, satisfactory results for this charge were indicated. This development was carried on at Picatinny Arsenal, Dover, New Jersey, and at Aberdeen (Md.) Proving Grounds. The required number of charges were loaded and fired. The results were found to be satisfactory.

Hoosier Ordnance Plant, Charlestown, Indiana, and Coosa River Ordnance Plant, Taladaga, Alabama, the two Bag Loading plants already in production, were offered the manufacture of flash-reducer charges on a production basis, but they did not care to accept the orders, as production scheduled at that time would not readily permit such an expansion.

New River Ordnance Plant was selected as the logical plant to produce this charge, as an organization was at hand and expansion could easily be adjusted within the organization.

In the spring of 1944, Mr. A. R. Hance, superintendent of the New River Ordnance Plant, with Mr. Henry N. Marsh, manager of the Smokeless Powder Operation for Hercules Powder Company, conferred in Washington with Mr. McGilvray and bag-loading officials from Picatinny Arsenal. Anticipated production difficulties were pointed out by Mr. Hance and Mr. Marsh. Suggestion for designing a flash-reducer charge bag that could be readily loaded on a production basis was made by Mr. Hance. This design was accepted and arrangement for production was approved

An alteration was ultimately made by the Radford Contract providing for the manufacture of 300,000 flash-reducer charges per month. This charge was originally known as Flash Reducer T1; then as perfection was established, the designation was removed from the technical status, and the item was designated Flash Reducer M1.

b. Pilot Lot Production

Hercules was requested to draw up plans for the rehabilitation of the Igniter lines for Flash Reducer Loading.

By May 22, 1944, the Engineering Department had completed conversion of the Igniter Line No. 2, and loading of the pilot lots was started by the New River Bag Loading Department. Pilot lots produced were tested at the Firing Range at Radford Ordnance Works. Satisfactory results were finally obtained after several changes were made in the method of loading the flash-reducer charge cells in order to increase efficiency and to speed up loading without affecting the firing results. Cups of various sizes were developed in order to increase the uniformity of weight of each charge dipped. The potassium sulphate grains were not uniform in size, resulting in erratic portioning of the dipped charges. The size and shape of the loading funnel was altered to overcome problems that presented themselves in the Loading Operations, such as potassium sulphate grains hanging in the funnel

The flash-reducer charge was designed for use with the 155 MM guns - M1917, M1918, M1 - and modifications. The charge, composed of two red cotton strips separated 6" apart, was wrapped around the propelling charge for these

guns and tied in place with seven cotton or silk tie tapes evenly distributed throughout the length of the charge. Each strip of the charge was approximately 4.75 inches wide and 36 inches long. The strip was composed of two sections; the upper- and lower-base charge section was 25 inches long, whereas the increment charge was 11 inches long. Each of three charges in each strip was divided lengthwise into three channels; each channel was in turn divided crosswise at the center by a seam, making 6 cells in each one of the 6 parts of the charge, or 36 cells in all. The two outside rows in each strip were filled with a mixture of 60% potassium sulphate and 40% black powder. The center rows contained straight black powder. The increment charges were attached to the end of the lower-base charge by a tab of white cloth stitched to each charge. This provided an easy means of separating the increment from the base section in the event that the normal 155 MM Gun Propelling Charge was to be fired. In case the supercharge was to be fired, the increment section remained a part of the flash-reducer charge. See photographs on Pages 510 and 511.

Potassium sulphate, when fired with black powder, was vaporized, producing a dense white smoke-screen effect that masked the muzzle flash normally visible during night firing.

The screening and drying of black powder began May 19, 1944.

The Flash Reducer Line at New River Ordnance Plant, converted Igniter Line No. 2, was opened on May 22, 1944, under the direction of Mr. Sydnor as supervisor, Mr. Kenney as shift supervisor, and Mr. Sherman Henderson as house foreman, with nine female operators. One complete charge was loaded during this shift. The second shift on the same day completed fifty charges.

Production on the first five days was as follows:

May 22..... 51 Charges
May 23.....176 Charges
May 24.....151 Charges
May 25.....213 Charges
May 26.....191 Charges

This completed the first pilot lot, which consisted of 750 charges.

On May 24, some of the charges were made with silk assembly tape; some with cotton assembly tape; and some were assembled by means of zig-zag sewing.

The building was then cleaned and re-opened on June 1, 1944. The second pilot lot, No. 263, was loaded. It consisted of 90 charges. The first bags of Lot No. 263 were made with outside channels of 1 inch width and center channels of 1 1/8 inch width. Of the 90 charges loaded on this lot, 10 were of special mixture.

The building was again cleaned, and on June 21, 1944, Pilot Lot No. 277 was started. Special potassium sulphated black powder blended with regular black powder with A-1 mixture was used to load 50 charges of that lot. This special powder was made by Hercules. It reduced the flash but not as effectively as the regular mixture.

On Lot No. 278, a special blend of potassium sulphated black powder, consisting of Grades A-1, A-8, A-12, A-3, and A-4, was used to load 55 complete charges.

The regular blend, which consisted of 60 percent K^2SO^4 and 40 percent of regular black powder was used to load 48 charges on Lot No. 279.

The third shift started on July 2, 1944.

On account of irregular granulations of the sulphate, it was very difficult to maintain a uniform mixture of black powder and sulphate. A box with a screen of No. 16 Mesh was used to screen out the fine grains and leave on top the grains which were to be used.

Flash reducers were first loaded by hand. By this method an operator could average from 75 to 100 single bags per shift.

The Hand Loading Method began as follows:

Black powder and sulphate were blended in a tub in the Rest House.

The black powder and the mixture were then carried to the Hopper rooms where the hoppers were filled.

In loading booths, the blend and the black powder were weighed for each individual channel and poured through the funnels into the channel.

This method was very slow, and after a few days the mechanics developed volumetric cups for measuring the blend and the black powder. The cups were check-weighed with every tenth charge loaded. See photographs on pages 500-501.

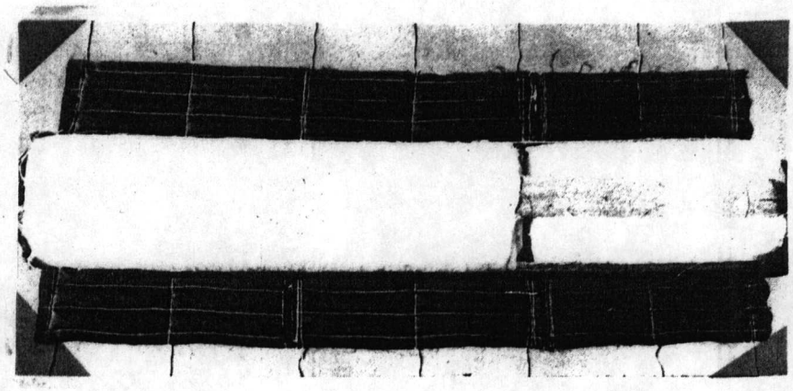
This type of loading failed to work satisfactorily on account of the inability to maintain a uniform mixture. This had proved satisfactory in laboratory experiments, but was not satisfactory for production because the necessary percentages of black powder and sulphate could not be maintained with the irregular granulations of sulphate. As a result there was too much variation in each channel.

Volumetric cups were then changed to allow the black powder and sulphate to be volumed separately and each charge mixed in a special mixing cup in order to maintain the correct percentage of each. The black powder for the center channel was volumed in the same manner and loaded through the funnel into the channel. Photographs of Pilot Lot Production Loading and Sewing Operations are found on pages 502-504.

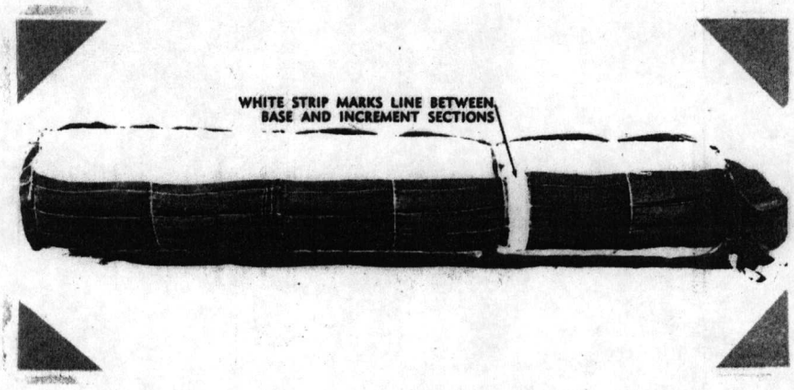
This type of loading produced such a limited number of charges that it was impossible to fill the quota needed by the armed services. Flash reducers were produced only at the New River Ordnance Plant. After the invasion of France began on D-Day, flash reducers were flown by cargo planes directly to the battle areas as soon as a complete shipment was loaded.

A request was made by the superintendent of bag loading, Mr. J. T. Sydnor, for a volumetric machine to be developed which would eliminate this slower method of loading flash-reducer charges. Mr. John Hunter, of the Inspection Division of the War Department, made an outline for setting up such a machine and turned it over to the Hercules Engineering Department for development.

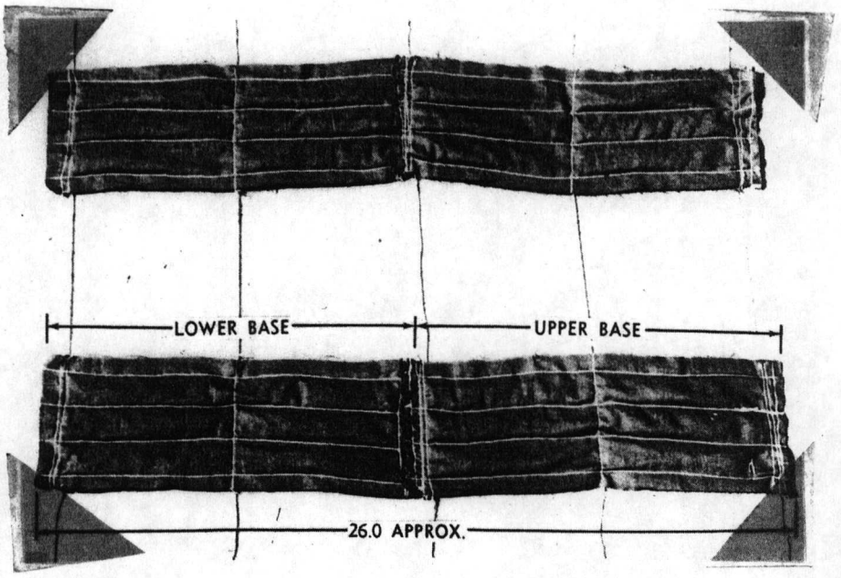
Smokeless Line 1 was opened on September 25, 1944, for the production of flash reducers. Production was continued on this line until December 31, 1944, then transferred to Line 3A until January 20, 1945.



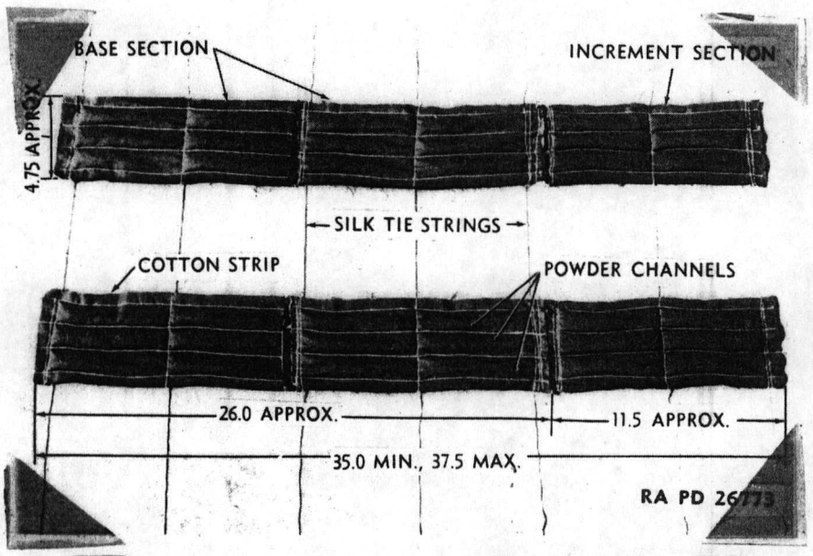
Propelling Charge (Supercharge) in Place on Flash Reducer



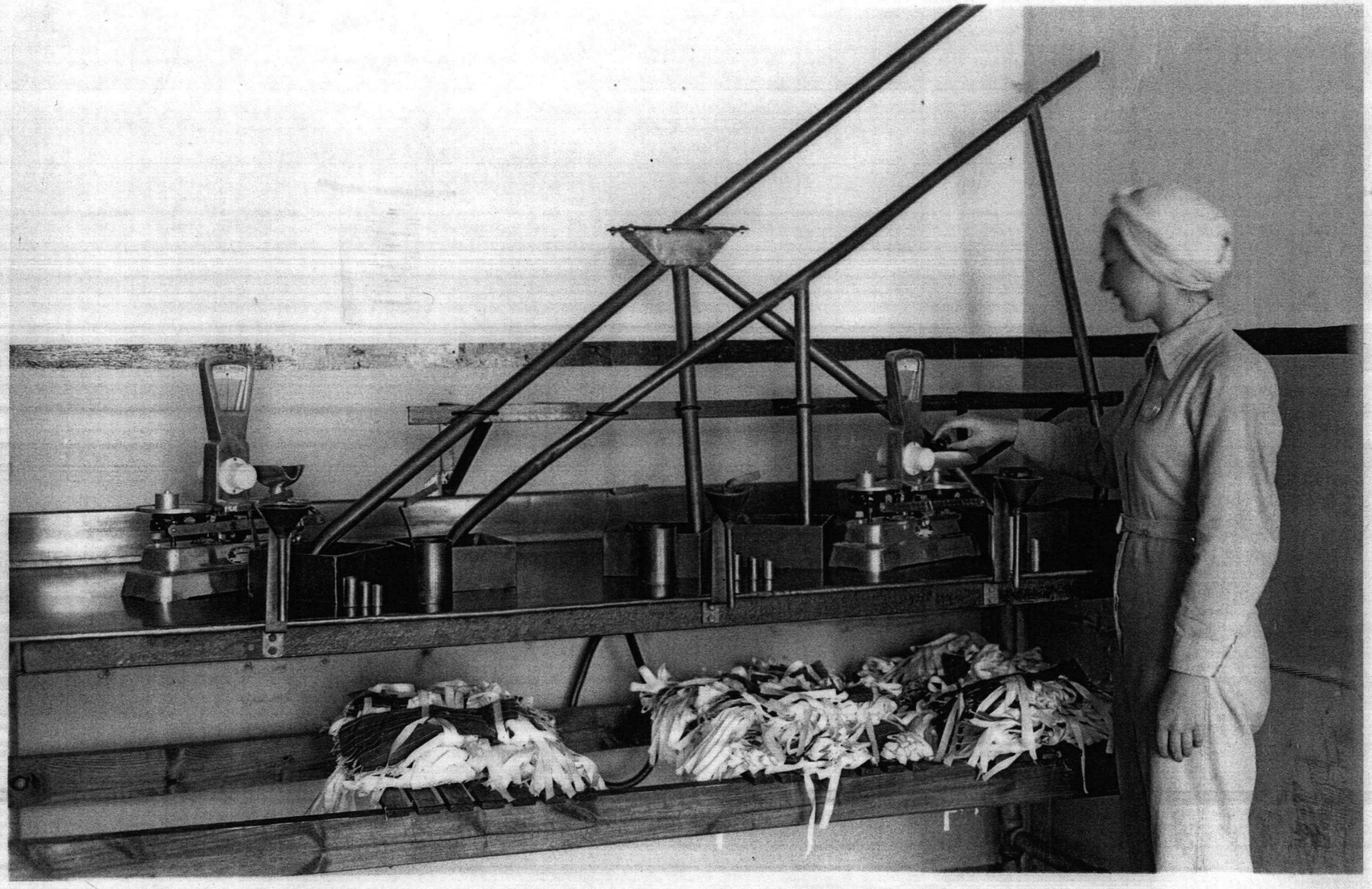
Flash Reducer T1 Tied Around Propelling Charge



Flash Reducer T1, Prepared for Normal Charge (Increment Section Removed)

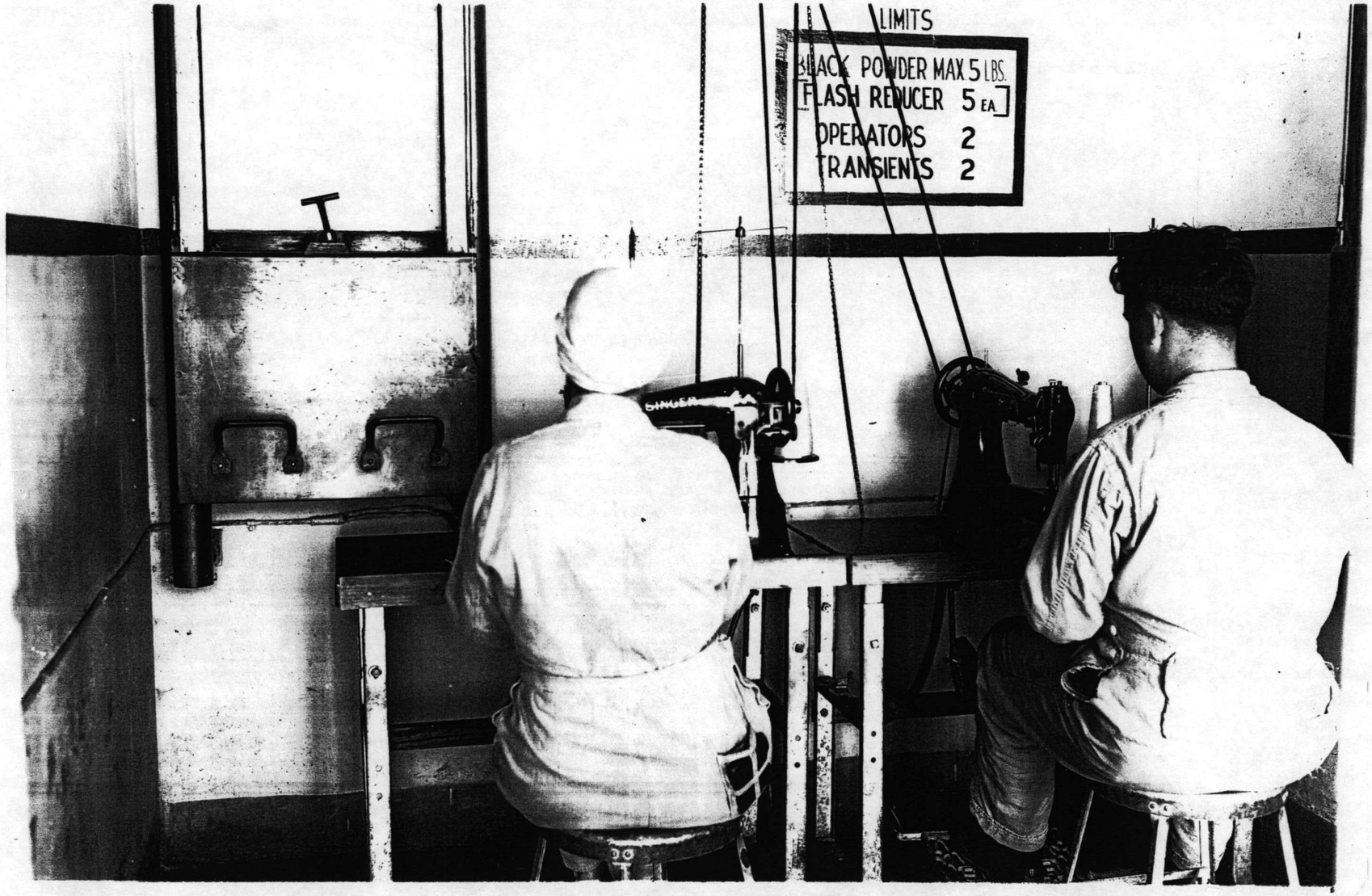


Flash Reducer T1—(Base and Increment Section)



HAND-OPERATED WEIGHING AND FILLING EQUIPMENT USED IN FLASH REDUCER PILOT LOT PRODUCTION NR-339

HAND-LOADING POTASSIUM SULFATE AND BLACK-POWDER CHARGE INTO AND OUTSIDE CHANNEL OF A FLASH-REDUCER BAG DURING PILOT LOT PRODUCTION NR P-6



SEWING HAND-LOADED FLASH-REDUCER CHARGES DURING PILOT LOT PRODUCTION NR-340

c. Standard Production Line

Production was started in the newly constructed Flash Reducer Houses as rapidly as construction was completed and as equipment was installed ready for use. Buildings were opened and operation commenced on the following dates:

Flash Reducer House No. 1 - November 20, 1944

Flash Reducer House No. 2 - November 26, 1944

Flash Reducer House No. 3 - December 6, 1944

Flash Reducer House No. 4 - December 31, 1944

Flash Reducer House No. 5 - January 8, 1945

Flash Reducer House No. 6 - January 18, 1945

Flash Reducer House No. 7 - January 29, 1945

Flash Reducer House No. 8 - February 7, 1945

The Flash Reducer Screen and Dry Line was completed and ready for operation on March 25, 1945. The distance provided between the Black Powder Incoming House and the Screen House, as well as between the Screen House and the Dry House, permitted the line to be operated at approximately 60% of its designed capacity. By virtue of the fact that New River was not rehabilitated to its anticipated full capacity, demands on the Screening and Drying Facilities, which included Screen and Dry Line No. 1, did not exceed its capacity. It was then, not necessary to correct the condition at the Flash Reducer Screen and Dry Line in order to process sufficient black powder to operate satisfactorily.

Production output had been sufficiently increased by March 6, 1945, to permit Hand Loading Operation at the Igniter lines to be discontinued. Flash Reducer lines were designed to produce five hundred charges per house per shift. This quota was reached during the month of January, 1945.

d. Flash Reducer Loading

(1) Job Orders and Production Reports

Job Orders for the loading of flash reducers were received by the supervisor of production of Black Powder Loading. When it was determined that

materials were available and information was correct, a copy of the Job Order was delivered to the shift supervisor and subsequently to the line foreman responsible for loading a particular lot of charges.

Arrangements were made with departments concerned for the delivery of supplies and powder in quantities in keeping with good production requirements and safety limitations.

Building Production Reports were made out in duplicate by the house foreman, one copy being retained and the original transmitted to the supervisor's office after being countersigned by the line foreman. Building reports were consolidated into a general report, summarizing daily production and carrying accumulative production to date for each type of charge loaded. Copies of the general report were sent to the Planning and Control Division and to the assistant operating manager, with the file copy being retained.

(2) Flash Reducer Line Arrangement

The Flash Reducer Line was provided with a separate Screen and Dry Line for processing black powder used in loading flash-reducer charges. Eight Loading buildings were serviced by an Opening-up and Rest House, an Inert Store House, an Empty Box Store House, an Outgoing Rest House, and a Maintenance Shop. Flash Reducer Loading buildings were identical except that No. 1 and No. 8 had two additional Inspection rooms used by Hercules final inspectors and Government inspectors. All Loading buildings had 6 Hopper rooms, 6 loading booths, 4 sewing booths, 1 Inspection Room,and 1 Packing Room. Inspection rooms and Packing rooms were equipped with high-speed super-sensitive sprinkler systems

(a) Screen and Dry Line

The Screen House was divided into an Opening-up Room and a Screener Room. Adjacent to the Screen House was the Motor Room housing the Powder Unit which drove the screener.

The screener, supplied by the J. H. Day Company, Cincinnati, Ohio, was a No. 32 Rubber Bearing Powder Sifter of all-wood, dust-tight con-

struction, having inter-changeable screen surfaces, each 20"-x-48", complete with screen cloth. The eccentric drive was enclosed in a dust-tight copper housing and a moulded rubber diaphragm seal. Metal parts of the eccentric dive, screen box, sieve frames, etc., were wired in series to the ground.

The sifter was powered by a one h. p. electric motor in the Motor House through a 12'-x-1½" bronze drive shaft.

Powder was fed to the sifter through a copper regulating feed hopper with a wood pulling valve. This was mounted on an independent supporting frame attached to the base of the sifter.

The Dry House was equipped with a Carrier Corporation Black Powder Drying Unit approximately 12' long and 6' wide by 7'2" high, divided into eight sections or compartments, each having a capacity to hold twelve trays approximately 22 3/4"-by-33" deep. Each tray held 25 lbs. of black powder. The capacity of the unit was 2400 lbs. of black powder. The dryer was a Carrier Standard, double-walled panel construction; door latches and hinges were brass - of the ice-box type. Copper flanges separated the point of contact between doors and panels.

Air entered the air plenum chamber from the top of the dryer and passed horizontally over the trays down through the tray mesh into the exhaust plenum.

Conditioned air was supplied to the dryer from the adjoining Fan House or Apparatus Room by a Carrier Silica Gel Unit, a dry air cooler activation booster heater, a Carrier 39R Fan Unit and 4-row water-cooling coil, and Dustop filters. Air was drawn from the outside through a set of Dustop filters, and during the dehumidification season, it was forced through the Silica Gel Unit, which action removed moisture. Dry air was passed through the Aerofin Non-freeze Booster Heater and the water-cooling coil and fan to the dryer.

The booster heater was capable of heating 3000 CFM of supply air from 0°F to 100°F. The water coil prevented the air from exceeding 150°F at the dryer. This coil was furnished as a safety precaution and was not used continuously. Air was exhausted to the outside from the dryer.

Safety controls were as follows: A thermostat was located in the air supply to the dryer, set at 150°F. so as to shut off the fan and steam and ring an alarm. A second thermostat was located in the same position, set to control the booster heater to deliver air at 145°F. If the temperature should rise above 147°F., a third thermostat would activate the water-cooling coil to cool the supply air to 147°F. Controls were arranged so that the outside air damper and exhaust air damper were closed when the fan shut off.

(b) Loading Buildings

Each Hopper Room was provided with two copper hoppers 10"-x-12" rectangular tops, three sides tapering at about 60° to an outlet at the bottom connected to a 1" copper tube protruding at an angle through the wall to the volumetric dispenser in the loading booth. The hoppers were elevated to permit gravity flow. One hopper was used to supply black powder, the other was for potassium sulphate.

Loading booths were each equipped with a volumetric dispenser designed to load three separate channels of the flash-reducer bag at one time. The two outside channels were to be filled with a mixture of black powder and potassium sulphate, and the center channel with straight black powder. A cylindrical proportioner was rotated approximately one-fourth turn and back by use of a crank-type handle to complete one filling stroke. Plungers penetrating the three funnel stems served to remove all particles of the charge from the dispenser. This was actuated by a separate lever. The dispensers were mounted on brackets above copper-covered wood tables. Transfer chutes designed to prevent propogation of flame connected the loading booths with the sewing booths. The chutes were closed with counterbalanced vertical sliding copper or aluminum doors on each side. A sliding bar locked one door in place while the other was

being opened, thereby isolating the rooms from each other at all times.

Each sewing booth was equipped with two Model 17-16 Singer Sewing machines. These machines sewed with a lock stitch. Sewing-machine table tops were copper-covered. A special copper platform at the sewing-plate level was provided on machines used for joining and assembling charges.

Power was transmitted by a 1 h. p. motor driving two machines through a drive shaft and a flat belt to the transmitter and a round belt drive to the sewing-machine head. A five-sided, copper-covered wood table was mounted directly below the Loading Room transfer chute to permit a flow of charges from the closing machine to the joining machine.

Inspection rooms and Packing rooms were equipped with copper-covered steel tables - 30"-x-72" tops, 36" high, for inspecting and wrapping charges.

(c) Service Buildings

Hold Houses and Rest Houses were of flame-resistant frame construction, barricaded on sides facing Operating and Storage buildings and located at distances from other buildings in agreement with the quantity - distance tables provided in the Ordnance Safety Manual. Store Houses were of frame construction and located at points accessible to operation. The Machine Shop was equipped with benches and tools necessary in maintenance of sewing machines and dispensing machines.

(3) Personnel

Personnel required to operate the Flash Reducer Line on a one-shift basis was as follows:

Line Foremen	- 2 (for area)
Area Foremen	- 2 (for area)
House Foreman	- 1 (per bldg.)
Powder Man	- 1 (per bldg.)
Volumetric Operators	- 6 (per bldg.)

Sewing Machine Operators	- 8 (per bldg.)
Inspectors	- 3 (per bldg.)
Packers	- 2 (per bldg.)
Service Man	- 1 (per bldg.)
Check-Weigh Inspector	- 1 (per bldg.)
Relief Operators	- 3 (per bldg.)
Mechanics	- 1 (per bldg.)
Janitors	- 2 (for area)
Material Handler and Checker	- 1 (for area)

(4) Materials

Essential materials for a flash reducer consisted of empty charge bags, Scutan bags, adhesive tape, thread, tabs, and potassium sulphate. These supplies were received at the Inert Storehouse for distribution to the Operating buildings. Shipping boxes were stored in the Empty Box Storehouse. The material checker maintained complete records of all materials distributed. It was his responsibility to see that an adequate working supply was maintained and that the Service Department deliveries were made according to schedule.

Black-powder cars received at the Magazine Area were sampled upon arrival, tested for moisture content, and complete analyses made on the product. Results of the test were forwarded to the superintendent of black powder. Black powder was dried if the moisture content was above the allowable maximum.

(5) Screen and Dry Operations

The black powder was delivered to the Screen and Dry Area by the Magazine Department trucks. The cans of powder were placed in the Incoming Magazine and set in "pyramid" fashion 3 cans high, with 12 cans comprising one "pyramid." This method of stacking enabled the cans to be counted quickly and easily.

The powder was hand-trucked to the Rest Room of the Screener Building utilizing a four-wheeled cart for the purpose. This vehicle was equipped with a

rack that prevented cans from falling off. Approximately 4 to 6 cans were hauled at one time; the trucker also checked the powder lot number as an added precaution.

Non-sparking tools of beryllium copper were used to open the cans in the Rest Room, and the contents of each can were poured into the metal transport shells. This allowed easier and faster handling of the powder at the screener proper, since the opening in the manufacturer's container was small. When emptied, the latter cans were flushed out with water, carted back to the platform at the Incoming Magazine, and subsequently hauled away by the powder truck. They were later flattened out and disposed of.

The powder was then poured from the shell into the hopper of the screener, and the contents of one can (approximately 25 lbs.) were screened at one time. A four-mesh screen cloth was used to separate the powder. Two metal cans were placed at the base of the screener, one for the acceptable powder and one for the oversize. These cans were held in a rack which prevented them from toppling over when the screener was operating. All personnel were evacuated from the room, the doors closed, and the screener was set in motion by pressing an outside switch located near the Rest Room. The plug in the hopper was removed, from a remote position, and the powder flowed over the screen. All powder passing through the screen was acceptable powder; it entered one of the receiving cans, whereas any foreign matter and oversize grains passed into the other can. The screening was completed when the sound of the powder falling into the cans ceased. The "stop" button on the switch was pressed, and one operator removed the receiving cans while another put the hopper plug into place and poured contents of another can into the hopper. Empty receiving cans were set in their proper sections in the rack, and the operation was then repeated.

The acceptable powder was brought to the Rest Room, and if necessary, additional screened powder was poured into the can to bring its contents up to twenty-five lbs. A scale was provided in the room for this purpose. Having each

can contain a uniform amount enabled the records of the consumption of the powder to be easily compiled. The lid of the can was then placed into position, care being taken to insure the presence of the necessary gasket. A slip showing the lot number and the grade of the powder was secured to the top of the lid by the spider clamp screw, which was then adjusted to make the can air-tight. All powder that was to be dried was hand-trucked to the Screener Magazine, whereas powder that had an acceptable moisture content was taken directly to the Outgoing Magazine. A four-wheeled hand-propelled cart, equipped with the necessary rack, was utilized for this purpose.

Cans containing powder that was to be dried were allowed to accumulate in the Screener Magazine; and when approximately 2,000 lbs. were available, the powder was hand-trucked to the Dry House. The Heating Unit had been previously started, thus allowing the unit to heat up. The trays were taken out of the dryer and placed on a table provided for that purpose, and the contents of the cans were spread out on the trays. One tray was filled and put back in the dryer before the succeeding tray was filled. The doors to the dryer had to be closed each time, thereby allowing only twenty-five lbs. of black powder to be exposed at one time. After the unit was loaded and its doors secured in place, the doors to the room were locked, thus preventing anyone entering while the unit was in operation. The heat in the dryer would level off at approximately 146 to 148 degrees, and a check of the recording chart would show the time it leveled off. The powder was allowed to dry for 3½ hours, at which time the Heating Unit was shut off and the dryer emptied. The dried powder was poured from the trays into the cans through a hopper designed for this purpose. Again only twenty-five lbs. of exposed powder was to be allowed at one time, the exception being, of course, when the dryer doors were opened to remove a tray. This also held true when loading the unit. The cans again were checked for gaskets, identification slips were put in place, and lids were secured. The cans of dried powder were then hand-trucked to the Outgoing Magazine, and the dryer and the room were thoroughly cleaned.

Delivery tickets for all powder removed from the line were made out by the foreman, who retained one copy that was sent to the office with his report.

All equipment was grounded and hand rails were provided at the entrances of Operating rooms, which fact allowed the persons entering to discharge any static electricity from their bodies.

Continual washing out, cleaning, and mopping up were in order on this line as often as necessary.

"Personnel and Explosives Limits" had to be maintained, and operating procedure followed.

(6) Flash Reducer Operation

(a) Operating Supplies

Dry, screened black powder was delivered to the Opening-up Room in quantities that did not exceed 500 lbs. in the room at any one time. Containers were wheeled to the Loading Building by the powder man; the black-powder hoppers were filled; and a working supply was maintained.

Potassium sulphate was transferred by the powder man from the barrels in which it was received at the Inert Storehouse to containers holding about twenty-five lbs. Potassium sulphate hoppers were filled and replenished as required.

The service man received a working supply of empty flash-reducer bags, Scutan bags, adhesive tape, tabs, and thread from the Inert Storehouse for distribution to the operating booths. Empty bags were delivered to the loading booths, tabs and thread to the sewing booths, and Scutan bags and adhesive tape to the Packing Room.

(b) Volumetric Loading Room Operation

Before loading, the flash-reducer bag was composed of an upper-base section, a lower-base section, and an increment section. The sections were made up of 2 identical parts, each divided into 6 cells. The two parts of

the section were attached parallel approximately 6" apart with cotton tape. The base sections were the same size and smaller than the increment.

Four booths were assigned to load base charges and two to load increments. Volumetric dispensers were adjusted accordingly. All booths operated in the same manner.

The operator, seated before the dispenser, slipped the openings of one end of one half of a section over the three funnel stems. The dispenser lever was moved to the upward position; the plungers were actuated sharply; and the lever was returned to the original position. The filled channels were removed, and the corresponding end of the other half of the section loaded. The open ends were placed together and folded to prevent powder spillage, and a clamp was attached. The operation was repeated for the other ends of the sections, making certain at all times that no powder was spilled from the channels. Loaded sections were placed in the transfer chute to the sewing booth, the operation proceeding until fifteen sections were loaded. The transfer chute door was closed, the lock bar pulled, and the operation repeated.

Accuracy of the dispenser was checked at frequent intervals by the check-weigh inspector. Portions dispensed were accurately weighed, and adjustments were made when indicated.

(c) Closing - Joining - Assembling

Base-closing and joining sewing booths were each serviced by upper-base and lower-base loading booths; the increment-closing and assembly booth was serviced by an increment-loading booth, joined bases to be attached to the increment section being transferred through a chute by the base-joining operator.

Sewing machines were started by throwing a starter switch on the outside of the booth. The operator was seated and made certain that the machines were properly threaded before the operation was started.

The base-closing operator removed loaded charges from the transfer chutes and placed them at the right of the sewing machine. The clip from one end of the cells was removed, and two straight seams were sewed across the dotted guide line of each part of the section, 1/16" apart. Threads were cut; the clamp was removed from the other end of the section; and the operation was repeated. Clamps were returned to the loading booth as a new supply of charges was taken from the transfer chutes.

The upper- and lower-base sections were attached by the joining operator at the second machine. Closures were overlapped at guide points and sewed with a double seam. Joined sections were transferred through a chute to the assembler in the adjoining booth.

Increment sections were closed in the same manner as the bases. The assembler joined the increment to the upper base by attaching each to a cloth tab 1" wide with a single seam through each section.

Assembled charges were placed in containers for transfer to the Inspection Room. Photographs showing Flash Reducer Loading, Closing, and Joining Operations are found on pages 518-520.

(d) Process Inspection

Each charge was thoroughly inspected to make certain that all specifications were met. Charges were removed from containers and placed on the inspection table. One inspector weighed the charges, and after physical inspection, folded them, placing five on a tray for transfer through a chute to the packing booth. Two inspectors examined the weighed charges for the following conditions:

Stitching closed and spaced correctly.

Channels filled with proper amount of powder.

Upper base attached to lower base with double stitch.

Straps not twisted.

Correct stencil markings on bags.

Bags properly sewed together - increment to upper base to lower base. . .

Oil on bags.

Length of charge to be 35.0 to 37.5 inches.

(e) Packing

The folded charges received from the Inspection Room were individually placed into Scutan Waterproof Protection bags; the excess air was removed from the bag by compressing it closely around the charge; the end of the bag was closed with a special fold to prevent air re-entering; and the closure was secured with a piece of adhesive tape.

Empty shipping boxes were received and stored at the Box House near the outgoing Hold House and were supplied to the Packing Room as required. These wooden boxes were equipped with hinged lids and inserted metal liners. Each was filled with forty-five wrapped flash-reducer charges. A groove around the top of the metal liner was filled with luting compound, and the metal lid was pressed into the luted groove. The lid was closed and catches engaged. Catches were sealed with a wire and with a lead seal, bearing the Ordnance Department insignia.

Filled containers were wheeled to the outgoing Hold House for temporary storage until received by the Magazine Department.

(f) Safety Measures

Rooms or buildings in which black powder was handled were frequently inspected for black-powder dust. This dust was removed with a damp cloth. Cleanliness in these buildings was maintained at all times.

If powder was spilled on the floor, all operations in the booth had to be stopped until all powder dust and fine particles had been brushed up clean and placed in a specially designed waste-powder can. These cans were in each room and were painted red for this purpose.

All safety tools used in opening or closing black-powder containers were made of non-ferrous metal. This applied to cups used for weighing or dipping charges and to cutters or scissors used in sewing or packing booths.

Extreme care was used at all times in handling containers of black powder. Operators were never permitted to slide them.

All equipment was electrically grounded before it was used.

Black-powder operators were provided with change of safety coveralls for each day as well as with wear conductive safety shoes.

Personnel and explosives limits were posted in all Operating and Powder Storage buildings, and strict adherence to these restrictions was required.

(g) Ordnance Acceptance Inspection

After completion of the flash reducers and inspection by the contractor, the Ordnance Inspection Department inspected a representative sample of loaded flash reducers in accordance with the Standard Sampling Tables (III or IV), checking those sampled against the applicable drawings, specifications, and classification of defects.

(1) Sub-lot Size

One sub-lot of flash reducers was considered as the proper production of a group of four buildings in one shift.

(2) Inspection for Volumetric Machine Adjustment

The Ordnance Inspection Division assigned one inspector to make a periodic check of the percentage of each ingredient delivered by each volumetric machine. This inspection was performed on a roving basis, with result tabulated daily to serve as a check that no machines were overlooked. Immediate correction was required for any machine found out of adjustment, and work produced by that machine was heavily spot-checked for incorrect weights.

STANDARD PRODUCTION METHOD OF LOADING FLASH-REDUCERS FROM A VOLUMETRIC DISPENSER
NR-6

CLOSING A FILLED FLASH-REDUCER SECTION IN STANDARD PRODUCTION NR-7

JOINING THE CLOSED FLASH-REDUCER SECTIONS IN STANDARD PRODUCTION NR-8

(3) Inspection for Packaging

Inspection for packaging was conducted by Standard Sampling (Table III or IV), using as a sub-lot size the production of about 5 or 6 shifts' work so that about 10 or 12 packing boxes were inspected each shift. Boxes were opened after being packed, sealed, and banded by the contractor. The samples for flash-reducer inspection were taken at random from the boxes opened for packing inspection.

(h) Safety Record

The Black Powder Loading Department, under which Flash Reducer Operation was carried during 1945, experienced one lost-time injury. This occurred to a house foreman who was attacked during the performance of his duties and as a result received a broken jaw. The frequency for this department was 1.0 and the severity 0.03.

12. Bag Loading Renewal

Change Order No. 29 to Contract ORD-462-DA-W-ORD-26, dated August 9, 1944, directed Hercules Powder Company to proceed with the necessary work for the rehabilitation of the New River Ordnance Plant and the production of propelling charges. Considerable preliminary work had been in progress prior to receiving this change order. Much of the needed equipment had been located, and arrangements for transferring many former New River employees back to the plant were well under way.

All operating equipment had been removed from lines when the plant was shut down in May, 1943. Surplus at the other plants served as a source for replacing much of this needed equipment. The remainder was procured directly from manufacturers. New construction, revamping, and installation of equipment was done by the Mason and Hanger Company.

Many of the key personnel that had previously worked at New River were returned as shift and line supervisors. Messrs. Sladek, Glover, and Scheff were returned from Port Ewen as shift supervisors. Trained supervisors were obtained

from other Hercules plants, but they had to be trained in Bag Loading Operations, since they had not previously worked in a Bag Loading Plant.

The employment division was able to obtain a nucleus of employees who had previously worked at New River with sufficient knowledge of Bag Loading Operation to begin the production work. Buildings were opened as soon as the contractors released them from construction, and by using the trained operators as instructors for the new employees, the buildings were put into actual production immediately. Lack of experience of the new employees limited for some time the amount of production that could be made.

The first type of charge loaded was the 105 MM Howitzer, M2, M2A1. Production on this charge was started on September 14, 1944, on Line 3-A. The steps for loading this type of charge are found on pages 524-526.

Production was started on the 155 MM Howitzer, M4A1 on November 21, 1944, on Line 3-B, and was moved to Line 1 on December 17, 1944. The steps for loading this type of charge are found on pages 455-457.

Because of the shortage of manpower, it was impossible to meet the production schedules required for the 105 MM Howitzer. Hercules was notified through the War Manpower Commission that enough colored people could be obtained to man an Operating Line by transporting them from the Roanoke Area. Prior to this time, all production was carried on with white operators.

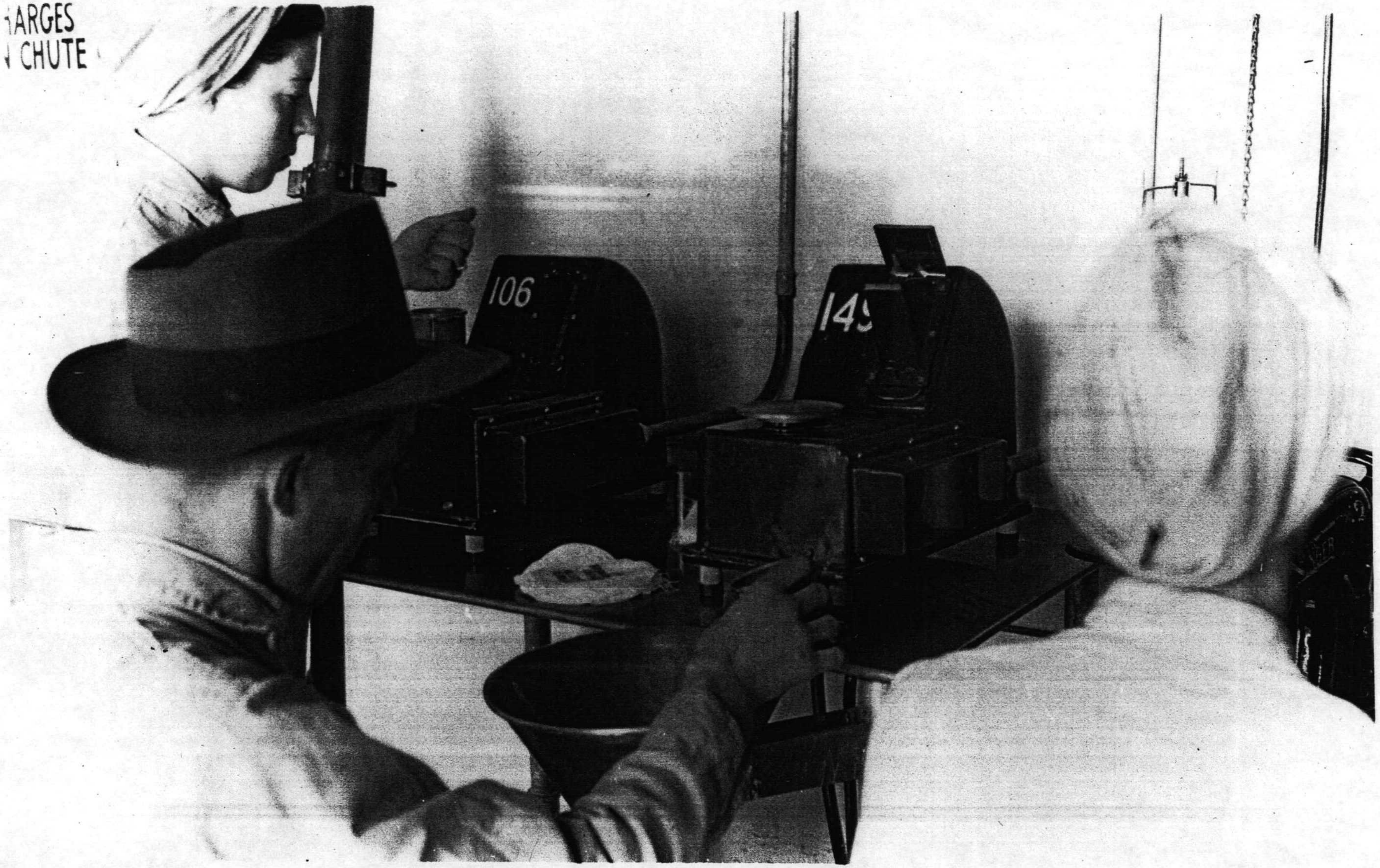
Line 2 was opened with colored operators on December 19, 1944. A training program using inert materials was carried on for four days with experienced white operators as instructors. These instructors remained on the line one month to assist the operators until they were capable of taking over the production work. The 105 MM Howitzer was produced on this line.

Job Instruction Training (J. I. T.) classes for instructing supervisors in methods of training operators were started in November, 1944. All line, area, and house foremen attended classes for two hours for five days. After the completion of these classes, the foremen conducted instruction classes for operators

selected for leadership ability, in order to have sufficient number of trained instructors to take care of the increase in personnel.

Operations were scheduled to utilize equipment as rapidly as it was received. Production lines were set up for single operation in order that production could be carried on immediately. As soon as sufficient equipment could be procured and personnel hired to equip and man the lines, they were converted to permit two teams of operation to work in the loading booths.

Installation of equipment was started on Line 3-A, August 29, 1944, and on Line 3-B, September 5, 1944. Line 3-A was completely equipped for loading 105 MM Howitzer, M2, M2A1 Single Operation, that is, one loading team per booth, by September 14. Line 3-B started single operation September 18 and continued until November 18, when it was again turned over to the construction contractors to be converted temporarily to the 155 MM Howitzer, M4A1 Loading. 105 MM Loading was continued on Line 3-A until December 16, at which time this operation was transferred to Line 2-A. This line had been converted to permit double operation or two teams per loading booth. After a satisfactory training period, colored employees operated Line 2-A until production was suspended August 15, 1945. Line 2-B, having been converted to permit double operation, was manned with colored operators, and production on 105 MM Charge was started January 15, 1945, continuing through production of this charge. Line 3-B was converted to 105 MM Double Operation after having produced 155 MM charges for nearly a month. 105 MM Operation was resumed January 22, 1945, with a white crew of operators, continuing operation until production was suspended August 15, 1945. Line 3-A was used to produce flash reducers from December 31, 1944, until January 19, 1945, then converted to 105 MM Double Operation. Production of 105 MM charges was resumed on this line February 18 and continued until production of this charge was stopped August 15, 1945. Limited 105 MM Howitzer Production was maintained on Line 4-B from July 16 to August 10.



BAG LOADING OPERATION

105mm Howitzer, M2, M2A1, Loading Operation. (Left to right - weigh and trim; check-weigh and bag; sewing.)

NR P-3

534

COLORED OPERATORS LOADING 105 MM HOWITZER CHARGES

NR-9

ASSEMBLING AND INSPECTING 105 MM HOWITZER M2, M2A1 CHARGES NR-10

It was not necessary to shift production of 155 MM Howitzer, M4A1 as often as the 105 MM Operation. Igniter Loading started on the Igniter Line No. 2 November 13, 1944. Utilizing one half of the line previously producing flash-reducer charges, operation continued on this line until March 5, 1945, at which time the production was transferred to Igniter Line No. 1 and remained on this line until August 1, 1945. In order that supervision of Black Powder Operation could be continued more effectively, igniter production was returned to Igniter Line No. 2 on August 1 and continued until plant production was stopped August 15, 1945.

Loading of 155 MM Howitzer Charge was started November 21, 1944, on Line 3-B, Mason and Hanger Company having completed the temporary conversion. Flash Reducer Production was discontinued on Bag Loading Line No. 1-B, November 5, 1944. Mason and Hanger Company commenced alterations immediately and had the line equipped for standard 155 MM Howitzer M4A1 Production on December 17, 1944. Operation was moved from Line 3-B to Line 1-B on that date. Line 1-A also temporarily used to produce flash-reducer charges was converted to 155 MM Howitzer Production between January 1 and January 9, 1945. Operation started on that date. Production continued on these lines until conclusion of operation August 25, 1945, except for the period June 3 to June 28, 1945, on Line 1-A, during which time the line was shut down for maintenance and repair. Production was transferred to Line 4-A, previously converted from trench-mortar increment packaging to 155 MM Howitzer Production. Line 1-B was shut down for repair from June 28 to July 16, 1945.

13. Bag Loading Department Divided

The volume of production had increased by January, 1945, to the extent that it was considered advisable to divide the Bag Loading Department into two separate departments, namely, the Smokeless Loading Department and the Black Powder Loading Department. Mr. J. T. Sydnor was retained as supervisor of production, Smokeless Department, and Mr. Chas. W. Sladek, formerly assistant

supervisor of the Bag Loading Department, was promoted to be supervisor of production, Black Powder Department.

The new Black Powder Loading Department was responsible for processing and loading all black powder. This included screening and drying black powder; loading igniters for 155 MM Howitzer, M4A1 charges; and loading flash-reducer charges.

Loading of smokeless propelling charges 105 MM How., M2, M2A1, and 155 MM Howitzer, M1, M4A1 was continued under the responsibility of the Smokeless Loading Department.

An Organization Chart of the Bag Loading departments as they functioned in 1945 is found on Pages 545 and 546.

Production and personnel reports for 1944 and 1945 as well as other pertinent statistical information are found on Pages 539 through 544.

MONTHLY PRODUCTION FOR 1941

DATE	105 MM HOW. M2 & M2A1	155 MM HOW. M2 (W.B.)	TOTAL CHARGES PER MONTH
SEPTEMBER & OCTOBER	224,821	-	224,821
NOVEMBER	178,137	53,489	231,626
DECEMBER	220,958	213,303	434,261
TOTAL	623,916	266,792	890,708

MONTHLY PRODUCTION AND PERSONNEL REPORT FOR 1942

DATE	105 How. M2	155 How. M2 (W.B.)	155 How. M3 (G.B.)	155 Gun M1	8" How. M1 (G.B.)	8" Gun Mk VI-3A2	10" Gun	Igniter Assemblies 4.7 AAGun	Total Chgs. for the Month	Hrly Employees	Salary Employees
JANUARY	315,561	345,125		65,902					726,588	1,530	92
FEBRUARY	390,738	302,477		61,528					754,743	1,476	105
MARCH	405,572	231,966		73,680					711,218	1,396	95
APRIL	299,965			58,001					357,966	1,316	90
MAY	302,965			57,999					360,964	918	86
JUNE	300,008		150,004	71,649					521,661	897	71
JULY	300,023		150,000	11,462		2,000			463,485	898	62
AUGUST	349,998		150,001	26,742	35,000	5,000	1,149		567,890	889	61
SEPTEMBER	350,001		145,005	5,000	42,802	3,888	2,122		548,818	938	61
OCTOBER	450,006		144,893	9,988					604,887	895	57
NOVEMBER	450,021		144,994	30,000				30,000	655,015	967	56
DECEMBER	530,668		183,039	79,623				22,000	815,330	1,021	52
TOTAL	4,445,526	879,568	1,067,936	551,574	77,802	10,888	3,271	52,000	7,088,565	13,141	888

MONTHLY PRODUCTION AND PERSONNEL REPORT FOR 1943

DATE	155 Gun M1	155 How. M3 (G.B.)	105 How. M2	105 How. M2 (A.T.)	12" Gun M1888 & '95	8" How. M2 (W.B.)	8" How. M1 (G.B.)	8" Gun MK V1-3A2	105 How. M3	105 How. M3 (A.T.)	Igniter Assemblies 4.7 AA Gun	Test Loading	Total Chgs. per Month	Salary Emp for Month	Hrly Emp for Month
JAN.	117,110	192,388	353,416	-	2,000	-	13,678	-	175,724	-	-	-	854,316	51	866
FEB.	113,444	162,233	515,643		1,131		9,079	2,000				104	803,634	52	879
MARCH	110,523	155,636	506,048	250,048	908	10,427	10,000	2,113					1,045,703	41	836
APRIL	50,710	4,360	224,961	37,800	781	5,679	10,001	2,000	75,702	25,056		1,000	438,050	38	787
MAY	38,153		14,583						51,653	66,629	20,100		191,118		
JUNE															
JULY															
AUGUST															
SEPT.															
OCT.															
NOV.															
DEC.															
TOTAL	429,940	514,617	1,614,651	287,848	4,820	16,106	42,758	6,113	303,079	91,685	20,100	1,104	3,332,821	182	3,368

MONTHLY PRODUCTION AND PERSONNEL FOR 1944

DATE	105 MM How. M2,M2A1	155 MM How. M4A1	Flash Reducer	60 MM M3	60 MM M3A1	81 MM M1	81 MM M1A1	81 MM M2	81 MM M2A1	Total Prop. Chgs. Per Month	Total Inc. Packages Per Month	No. Hrly Employees On Roll	No. Salary Employees On Roll
JAN.				149,152		609,380					758,532	88	5
FEB.				569,450 * 923,680	* 9,120	674,999 * 456,030		*161,2880			1,244,449	116	5
MARCH				4,309,050		683,207					6,542,367	188	5
APRIL				6,656,704		645,802		130,788			7,433,294	219	5
MAY			750	7,535,780				1,496,719		750	9,032,499	264	5
JUNE			1,023	3,288,989		1,936,422		1,975,34		1,023	7,200,725	259	5
JULY			32,430	5,335,425		3,349,973		206,585	1,019,490	32,430	9,911,473	247	9
AUG.			50,790	2,053,219		4,818,611		1,074,521	1,506,523	50,790	9,452,874	386	15
SEPT.	46,120		50,340	3,264,855		4,120,077			1,505,775	96,460	8,890,707	833	23
OCT.	201,200		118,050	5,459,664				598,697	535,745	319,250	6,594,106	1,103	24
NOV.	203,600	8,463	153,491		4,565,064		8,114,400		3,129,462	365,554	15,808,926	1,240	29
DEC.	52,360	60,387	174,000		6,385,050		4,599,770		2,138,605	286,747	13,123,425	1,743	30
TOTAL	503,280	68,850	580,874	39,545,968	10,959,234	17,294,501	12,714,170	5,643,904	9,835,600	1,153,004	95,993,377		

* Special Replacement Order

MONTHLY PRODUCTION AND PERSONNEL REPORT FOR 1945

DATE	105 MM HOW.	155 MM HOW.	FLASH REDUCER	10" MORTOR	TOTAL CHGS. FOR THE MONTH	NO. HOURLY EMP. ON ROLL AT FIRST OF MONTH	NO. HOURLY EMP. TRANS. OUT OF THE DEPARTMENT	NO. HOURLY EMPLOYEES TERMINATED	NO. HOURLY EMPLOYEES ON ROLL AT END OF MONTH	NO. SALARY EMPLOYEES FOR MONTH
JAN.	302,616	177,179	304,627		784,422	1,743	15	166	2,840	37
FEB.	324,416	195,181	314,800		834,397	2,840	32	281	2,703	42
MAR.	749,440	296,483	319,300		1,365,223	2,703 *	29	236	2,713	58
APR.	897,560	336,950	333,350		1,567,860	2,713	24	224	2,651	57
MAY	1,264,680	327,500	228,330	200	1,820,710	2,657	25	364 **	2,528	70
JUNE	1,283,160	300,000	140,040		1,723,200	2,528	16	852	1,784	65
JULY	550,324	155,672	130,290		836,286	1,784	47	879 **	864	32
AUG.	174,540	88,167	176,130		438,837	864	10	854 **	0	24
TOTAL	5,546,736	1,877,132	1,946,867	200	9,370,935	15,024	171	3,530	13,700	385

* Black Powder Personnel taken off of Smokeless Personnel as of March 1, 1945

** Large figure due to Reduction in Force

MONTHLY PRODUCTION AND PERSONNEL REPORT FOR 1945
OF ROLLED POWDER PACKING

DATE 1945	60 M/M Pounds	M3A1 Increments	81 M/M Pounds	M1A1 Increments	81 M/M Pounds	M2A1 Increments	Total Pounds Per Month	Total Increments Per Month	Hourly Employees on roll End of Month	Salary Employees on roll End of Month
JANUARY	58,111	9,069,133	85,354	5,558,010	134,709	4,714,815	278,174	19,341,958	252	10
FEBRUARY	68,477	10,966,075	102,062	6,634,030	106,068	3,712,380	276,607	21,312,485	288	8
MARCH	45,735	6,619,215	136,620	8,880,300	176,582	6,180,370	358,937	21,679,885	328	6
APRIL	51,707	7,376,625	141,111	9,172,215	137,093	4,798,255	329,911	21,347,095	174	6
MAY	50,212	8,267,023	146,902	9,548,630	107,885	3,775,975	304,99	21,591,628	166	6
JUNE	51,932	7,621,561	134,915	8,769,475	116,173	4,066,055	303,020	20,457,091	146	5
JULY	37,252	6,172,633	35,498	2,307,370	67,500	2,362,500	140,250	10,842,503	46	4
AUGUST	16,731	2,548,360			29,167	1,020,845	45,898	3,569,205	41	3
TOTAL	380,157	58,640,625	782,462	50,870,030	875,177	30,631,195	2,037,796	140,141,850	1,441	48

Chapter XXI

MAGAZINE AREA

1. Duties

The Magazine Area personnel received and stored all incoming powders, made all intra-plant powder transfers, shipped (stenciling with marking instructions when necessary) all powders and powder products from the plant, and kept permanent records of all powder movement and storage.

2. Organization

In August, 1941, a Labor Pool was formed to take care of various plant operations, which at the time did not justify permanently assigned labor. About two dozen men had been employed in the Labor Pool when the first powder was received in the Magazine Area in September, 1941. The men were used as powder handlers under the direction of a foreman to store the powder and transfer it to the lines for bagging. A foreman was placed in charge of receiving and shipping the powder at the Line Magazines. After about ten days of operations, a chief clerk was sent to the department to take charge of all clerical work. Operations increased rapidly, and by December, 1941, the personnel had reached about 70 powder handlers and 10 truck drivers. At this time it became necessary to appoint a Magazine Area supervisor and two more foremen. The work in this and other departments had assumed a uniformity that made it unnecessary to continue the Labor Pool. The superintendent of the Labor Pool had been directing the loading and bracing of railroad cars for shipment and was later made loading supervisor. By January, 1942, the work had reached such proportions that the department was compelled to borrow from 50 to 100 men from the Loading lines every few days in order to keep up with the work. In February, 1942,

the department personnel had reached about 160 explosives handlers — approximately 100 men on the 8-4 shift and 30 men on each of the other shifts. After the addition of a truck foreman and an assistant supervisor in April, 1942, the supervisory and office force consisted of the supervisor, assistant supervisor, supervisor of loading, 3 foremen in charge of shifts, a truck foreman, a line magazine foreman, and 4 office clerks. The explosives handlers worked in crews varying from 4 to 15 men under the directions of a man designated as work leader. The personnel organization remained about the same until April, 1943, when production began to decrease. Bagging Operations were discontinued in late May of that year, and the Magazine Area began operating as a Storage Depot with the former assistant supervisor and 2 foremen in charge of operations, which were carried on with about 50 explosives handlers for a few weeks, but this number soon had to be increased to about 80.

On September 19, 1943, Radford Ordnance Works officially took over management of New River Ordnance Plant, and the Magazine Area continued operating as a Storage Depot under the direction of a supervisor, who was classified as line supervisor, and two foremen, both of whom were classified as house foremen. The supervisory organization remained the same throughout the dormant period of the Loading lines and up to the close of this history. The operating personnel was increased at intervals until it consisted of 146 men. (See Organization Charts on pages 539-543.)

3. Area Description

In September, 1941, when the Magazine Area was turned over to Hercules Powder Company for operations by the construction contractors, it consisted of eighty-seven 80-ft. and two 40-ft. Igloos spaced from 400 to 1200 feet

apart and in elever rows containing from 3 to 12 Igloos each. The rows ran in a general north and south direction, approximately eight hundred feet apart. The Igloos were so arranged that all faced in the same direction, east. The hard-surface road system was designed in a manner comparable to a street running the length of each row in front of the Igloos with a drive looping therefrom to service each. Border roads connected the ends of the row roads, and inter-crossing and connecting roads were placed where necessary because of topography and in order to expedite travel within the area. Four railroad loading platforms aligned from 400 to 600 feet apart along a railroad spur which ran from the West Yard, through the plant site, to the southwest corner of the Igloo Area and a construction shack facing the loading platforms from across the main plant road entering the area completed the structural arrangement of the area at that time.

A building, formerly used for Guard Headquarters, was moved into a hollow about 300 yards from the southwest corner of the Igloo Area and was made ready for occupancy as an Office and Canteen Building in February, 1942. The construction shack, formerly used as the Magazine Office, was improved and used as a Field Office by the government inspectors and checkers. In March, 1942, another used building, about 20 by 40 feet, was placed about 150 feet east from the loading platform nearest the Igloo Area and used as a Carpenter Shop. An area about 100 by 50 yards north of the Carpenter Shop was used as a lumber yard.

Storage capacity for the area was greatly increased when, in March, 1943, Radford Ordnance Works completed construction of fifty-nine 27-by-62-foot barricaded Magazines. The Magazines were built on the outskirts of the Igloo Area and practically surrounded it on the south, east, and north sides. Sufficient distances were maintained, and barricade arrangements

were such as to permit capacity storage of cannon and small-arms smokeless powders in both Igloos and Magazines. The 89 Igloos and 59 Magazines occupied approximately 1,650 acres of land on the northeastern portion of the plant site.

4. Storage Limits and Capacities

Maximum storage limits, as determined by distance tables in the U. S. Ordnance Safety Manual, permitted 500,000 lb. of smokeless cannon powders or 250,000 lb. of small-arms powders per Igloo or Magazine. Maximum storage was attainable only when powders came packed in the less bulky type containers, such as Navy and metal-lined plywood containers. Since smokeless cannon powder usually came in 150,000-lb. lots, it proved more satisfactory for temporary storage to store three lots or 450,000-lb. in Igloos and Magazines if physically possible. The department considered powders that were expected to be moved within six months or less to be in temporary storage. Space in the Magazines was suitable for temporary storage of only two 150,000-lb. lots of smokeless cannon powders packed in containers of the metal-lined wooden-box type. However, space in the Igloos would accomodate three such lots. When three 150,000-lb. lots of powder were stored in an Igloo or Magazine, 1 was stacked across the back and the other 2 along the sides, leaving a 3½- to 4-foot aisle, running from the doorway in the center of the building the length of the two side lots. When only two 150,000-lb. lots of powder were stored in a Magazine, they were stacked on either side of an aisle running the full length of the building. It took considerably more space to store powder that was packed in metal containers of the type used for packing the 155 MM How., M1, M4 charge. The containers were bulky and heavier than the powder content, and more than 11,000 containers were required to pack a 150,000 lb.-lot of

powder. The department could place for temporary storage only one 150,000 lb. lot of powder packed in the above-mentioned containers in the Magazines; one and one-half lots could be stored in the Igloos. Small-arms powders and other powders falling in that category varied in lot size from 5,000 lb. to 60,000 lb. The density of the powder and the powder pack determined the physically possible storage weight per Igloo or Magazine. It was found that either storage building would accomodate the maximum limit in all small-arms and high-explosive powders yet received for storage except .30 calibre and .45 calibre, which were limited to an approximate 150,000 lb.

The two forty-foot Igloos were used exclusively for storage of black powder since operations started. Each accommodated a working storage of approximately 150,000 lb. of black powder. Working storage meant an amount of space wherein powder was moved frequently -- all or any part of which must be made readily accessible for use without disturbing storage arrangements. Working storage proved very essential for expediting movement of materials used constantly in production. It was necessary to assign other Igloos and Magazines for working storage during Loading Line Operations at this plant.

5. Operating Equipment

The original trucking equipment consisted of six 2½-ton Mack Diesel tractors, twenty-five 5-ton La Peer drop-trailers, six 5-ton and one 2-ton Mack Diesel van-type trucks for transporting powder within the plant, and three ½-ton pick-ups for transporting dunnage and other working materials. Other automotive equipment consisted of 3 vehicles for use by supervisory personnel and 2 large buses for transporting operators. Other equipment included about 3 dozen two-wheeled hand carts and about 1 dozen four-wheeled floats suitable for moving powder to and from the railroad cars and trucks.

About 3 dozen small Edison battery lamps furnished lighting for work in Igloos when necessary.

In April, 1942, one ½-ton pick-up truck and one 1-ton pick-up truck equipped with enclosed bodies were used for transporting small quantities of black powder and igniters. Early in the summer of 1942, the use of hand trucks and floats was superseded by the use of approved gravity conveyors, which proved to be a more efficient means of handling powder. At about the same time a power saw was installed in the Carpenter Shop to facilitate preparation of dunnage for bracing railroad cars. Later, the small Edison battery lamps were replaced by four large Edison battery flood lights.

The above constituted all major changes in equipment until Loading Line Operations were discontinued. At that time three of the 5-ton van-type trucks were declared as excess equipment, and were therefore turned over to the War Department. The ½-ton pick-up truck which had been converted into a powder truck was taken for use by the War Department. A couple of months later the two large passenger buses were sent from the plant, and immediately two 1½-ton stake-body trucks were converted for use for transporting workmen. Later, as personnel increased, it became necessary to increase the passenger transportation equipment until, at the present, there are four 1½-ton stake-body trucks and one 28-passenger bus in service.

In June, 1944, two of the vehicles used by supervisory personnel were replaced by two radio cars, which greatly added to operating efficiency by improving communications.

Later the department received four 2½- to 5-ton four-wheel-drive Studebaker tractors and fourteen 15-ton drop-trailers to be used in powder hauling as soon as the brake system was coordinated for use with that of the tractors.

6. Operations and Procedure

When the powder was received into the Magazine Area, the loaded freight cars were spotted at the loading platforms. The cars were opened, and bracing dunnage was removed by men assigned to that work. A powder trailer was spotted at the platform directly across from the freight-car door. The powder handlers, working in crews of from 8 to 12 men, started unloading cars. Originally the men used the two-wheeled hand carts to cart the containers of powder, one container per man at the time, from the car across the platform into the trailer. Two to six of the men worked at removing the powder from the stack in the car and at placing it in readiness for the other men to cart away. The men frequently alternated between removing powder from stack and working with hand carts, because the latter work was less strenuous. When the trailer was loaded, it was pulled out and dropped, and an empty trailer was moved into position for loading by a tractor driver assigned to the work of shifting for several unloading crews. Another driver picked up the loaded trailer and pulled it to the assigned Igloo or Magazine, where another crew of from 12 to 16 men were unloading the powder and stacking it in the building. The larger crew was necessary in order to unload the trailers as fast as the platform crew could load them. The Igloos and some of the Magazines had low platforms; hence the men were required to lift the powder down from the trailer, place it on four-wheeled floats, push it into the building, and stack it. The men alternated between the lighter and heavier work. Average crews of the above-mentioned numbers, working in the manner described, could unload and store approximately 150,000 lb. of powder per day. Including tare weight and considering that each container of powder had to be lifted four different times to complete the above-described storage operation, the average weight handled per man per day was about 35,000 lb.

When the hand carts and floats were replaced by the gravity conveyors, it was still necessary to lift each container of powder four distinct times to complete the operation of unloading and storage, but the lifting was not very strenuous except perhaps for the placing of the containers in the final stack. Clarification of the above statement may be made by pointing out that the conveyor sections could be raised and lowered to conform with the height of the powder stack, thus permitting powder containers to be handled on the same level without sheer physical force to raise and lower them. The use of conveyors to move powder increased the average weight handled per man per day to as high as 65,000 lb. Conveyors are now used wherever possible, because they can be used advantageously in handling almost all types of containers.

The methods of moving powder were virtually the same in all operations. The amounts possible to move within a specified length of time were controlled by several factors. Let us assume that a crew of men were assigned to the work of supplying a Loading Line with powder. The Line Incoming Magazine had a limit of 50,000 lb. of powder but, at the time of assignment, it already contained 10,000 lb. The crew must then limit their loading for that line to 40,000 lb. of powder, which could be placed on four trailers. The crew must move to the place of storage, set up equipment, load four trailers, take down equipment, and move to another assignment. Time spent in moving and setting up equipment in an operation of the nature just described very nearly equalled the time spent in loading powder. If enough conveyor equipment were avilable to place a setup in each storage building that contained a powder lot which was in process of bagging, then only the number of men capable of maintaining a constant supply of powder to a Line

Magazine would be assigned to that work. Thus, working efficiency could be increased almost 100 per cent in supplying powder to the Loading lines. Quantities of powder packed in containers and container types were other factors influencing possible amount of powder movement.

In June, 1943, the plant was issued its first instructions to mark certain information data on each container of powder in an out-going shipment. Since that time, it has been necessary to mark a large percentage of shipments, especially those loaded for export. At first stenciling marking instructions on the containers was tried but later methods of stamping marking instructions on containers with rubber stamps were devised. Containers were usually stamped as they passed along the conveyor line from the trailer into the freight car.

During the earlier period of operations, Ordnance specifications were not always available for loading and bracing the numerous types of powder containers in freight cars for shipment. Later, the department usually had to develop a loading plan for any new-type container, because shipments had to be made before loading specifications were received. The general plan of loading followed before June, 1943, was to stack powder containers compactly in each end of the freight car and leave about four feet of space in the center of the car for bracing. Bracing was usually accomplished by placing a gate against the powder containers on each side of the space and making the gates secure by nailing numerous staunch cross studdings between the two. The method required a vast amount of workmanship, time, and material. Later, whenever possible with the type of powder containers involved, the containers were stacked compactly in each end of the car but the stacks were brought as nearly together in the center of the car as possible. The space varied from a couple of inches up to twelve or more

inches. The space, if not too large, could be filled by dropping boards in pairs perpendicular to the floor of the car into the space at intervals along the tops of the stacks, and loading was thereby made secure by driving wedges between the pairs of boards. When the space was too large for wedging, gates and cross-studding had to be used.

During the first stages of operations, some difficulty was experienced in ascertaining correct amounts of powder lots received into the department. Later a method was developed which proved more satisfactory than any yet used. The house foremen in charge of unloading a car of powder counted each trailer load of powder and entered the number of containers with other relative information for each trailer load on a tally sheet, which designated the place of storage. The house foreman in charge of stacking the powder in storage counted the containers after they were stacked and listed the number of rows and the number of containers in each row on a tally sheet. The reverse side of the tally sheet had a combination diagram of both an Igloo and a Magazine with dimensions shown. The house foreman sketched the stacking arrangement of the powder lot on the diagram. The tally sheets were turned in to the office, checked with shippers' documents, and, when all were in agreement, permanent ledger entry was made. The diagram representing the stacking arrangement was posted lightly in pencil on a 3"-x-4" card, one of which represented each Igloo and Magazine in the area. The cards were displayed in numerical order of storage buildings on a large board. The arrangement was especially helpful in quickly determining locations of unoccupied space and in designating the order in which powder lots should be removed from storage.

Intra-plant powder transfers were directed by issuing delivery tickets in triplicate sheets of white, blue, and yellow. The yellow copy was signed

by the receiver of the other two copies and was retained at the point of issue (Magazine Office or Loading Line). The white and blue copies accompanied the shipment. The blue copy was retained by the received, who signed the white copy and returned it to the shipper.

7. Accident Experience

Lost-time injuries, which amounted to an approximate one for each 30,000 man-hours worked, varied in nature. One resulted from a hernia sustained while a man was lifting materials; another was due to the displacement of cartilage disk from between vertebrae sustained while a man was twisting his body and lifting materials onto high stack. Three or four injuries were caused by men straining their backs while handling materials. Two resulted from sprained ankles when men stepped from vehicles onto something uneven. Two or three men lost time because of severe reactions from compulsory vaccinations. Most of the other lost-time cases were caused by severe contusion or broken digital bones resulting from injuries sustained from falling materials or fingers being caught between materials in movement.

The trend of the minor injuries was definitely upward when there were a number of inexperienced personnel working and when operations were suddenly increased. Minor injuries varied in frequency from about 1 per 2,000 man-hours to 1 per 800 man-hours when computed in monthly periods for the past eighteen months. These injuries consisted principally of minor abrasions, slight lacerations, and bruises.

POWDER HANDLED IN 1941 N.R.O.P.

TYPE POWDER	ON HAND 8-1-41	RECEIVED Lbs.	To LOADING LINES Lbs.	From LOADING LINES No. Charges	From LOADING LINES Weight - Lbs.	SHIPPED No. Charges	SHIPPED Charges & Bulk Weight - Lbs.	ON HAND 12-31-41
Black	0	209,150	31,013					151,740 Lbs.
105 MM How. M2 & M2A1	0	3,654,381	1,805,966	607,218	1,821,654	449,784	1,349,352	1,848,415 "
155 MM How. M2 W.B.	0	5,874,306	1,405,789	165,387	1,395,452	165,387	1,395,452	4,468,517 "
155 MM Gun, M1	0	3,463,175						3,463,175 "
105 MM How. M2 & M2A1 CHARGES	0							157,434 CHGS
TOTALS	0	13,201,012	3,242,768	772,605	3,217,106	615,171	2,744,804	9,931,847 LBS. 157,434 CHGS

Black: To Igniter Lines 57,410 Lbs.
From Igniter Lines 57,410 Lbs.

COMBINED TOTALS:

Transferred without effecting inventory	22,520,510 Lbs. Net
	26,987 Lbs. Net
	5,112,741 Lbs. Tare
	27,660,238 Lbs. Gross

POWDER HANDLED IN 1942 N.R.O.P.

TYPE POWDER	ON HAND 1-1-42	RECEIVED Lbs.	To LOADING LINES Lbs.	From LOADING LINES No. Charges	From LOADING LINES Weight - Lbs.	SHIPPED No. Charges	SHIPPED Charges & Bulk Weight - Lbs.	ON HAND 12-31-42
Black	151,740 Lb	822,516	1,583,532		791,766			170,895 Lbs.
105 MM How. M2 & M2A1	1,848,415 Lb	15,115,111	13,346,310	4,440,000	13,320,000	4,440,000	13,323,520	3,613,696 "
105 MM How. M2 & M2A1 CHARGES	157,434 Cg							157,434 CHGS
155 MM How. M2 W.B.	4,468,517 Lb	3,776,054	8,085,599	980,973	8,276,959	980,973	8,435,931	0
155 MM Gun, M1	3,463,175 "	25,767,857	16,752,751	537,411	16,995,623	537,411	17,053,607	12,420,297 Lbs.
155 MM How. M1 for M3 G.B.	0	7,104,339	5,908,306	1,070,237	6,086,973	1,070,237	6,142,245	1,140,761 "
8" Gun, MK V-1	0	2,494,497	1,171,297	10,500	1,181,906	10,500	1,234,046	1,271,060 "
8" How. M1 for M1 G.B.	0	1,681,332	1,022,192	77,802	1,035,739	77,802	1,035,739	659,140 "
10" Gun	0	523,160	523,160	3,271	542,986	3,271	542,986	0
155 MM How. M1, M1917	0	60,086						60,086 "
75 MM Gun, M1	0	2,048,382					123,768	1,924,614 "
37 MM AA Gun, M1, A2	0	527,995					10,050	517,945 "
37 MM Gun, M4	0	651,204					76,719	574,485 "
40 MM Gun	0	1,411,062					105,146	1,305,916 "
57 MM Gun	0	1,294,202					135	1,294,067 "
.30 Caliber	0	550,958					550,958	0
.50 Caliber	0	1,903,245					801,684	1,101,561 "
12" Gun	0	444,280						444,280 "
8" How. M1, M2 W.B.	0	491,780						491,780 "
.45 Caliber Pistol	0	412,888						412,888 "
90 MM AA Gun	0	594,845					40,110	554,735 "
Mixed Lot Remnants	0				1,976			1,976 "
4.7 AA Gun Ign. Assembly	0			52,000	26,000	52,000	26,000	0
TOTALS	9,931,847 Lb 157,434 Cg	67,675,793	48,393,147	7,172,194	47,468,162	7,172,194	49,502,644	27,960,182 Lbs. 157,434 CHGS

Black: To Screen & Dry House 803,361 Lbs.
From Screen & Dry House 785,766 Lbs.

COMBINED TOTALS:

	214,628,873 Lbs. Net
Transferred without effecting inventory	1,197,650 Lbs. Net
	67,398,989 Lbs. Tare
	283,225,512 Lbs. Gross

POWDER HANDLED IN 1943 N.R.O.P.

TYPE POWDER	ON HAND 1-1-43	RECEIVED Lbs.	To LOADING LINES Lbs.	From LOADING LINES No. Charges	From LOADING LINES Weight - Lbs.	SHIPPED No. Charges	SHIPPED Charges & Bulk Weight - Lbs.	ON HAND 12-31-43
Black	170,895 Lbs	444,725	836,416		418,208		45,525	156,605 Lbs.
105 MM How. M2 & M2A1	3,613,696 "	5,449,269	4,537,129	1,636,875	4,910,625	1,794,309	7,657,713	2,251,050 "
105 MM How. M2 & M2A1 CHARGES	157,434 Chg							0 Chgs
105 MM How. M2 H.E.A.T. M67	0 Lbs	119,942	16,859	287,848	436,269	287,848	539,352	0 Lbs.
105 MM How. M3 H.E.A.T. M67	0 "			91,685	110,595	91,685	110,595	0 "
105 MM How. M3	0 "			303,079	400,973	303,079	400,973	0 "
155 MM How. M1, M3 G.B.	1,140,761 "	2,205,779	2,821,914	512,316	2,913,798	512,316	2,913,798	524,626 "
155 MM Gun, M1	12,420,297 "	17,601,691	13,440,881	444,103	14,044,758	444,103	26,808,807	3,817,058 "
8" How. M1, M2 W.B.	491,780 "	328,720	456,746	16,106	464,054	16,106	515,188	312,620 "
8" How. M1, M1 G.B.	659,140 "	480,075	565,388	42,758	569,216	42,758	869,263	273,780 "
8" Gun, MK V-1	1,271,060 "	2,089	656,689	6,501	784,190	6,501	1,181,385	219,265 "
12" Gun	444,280 "	839,400	1,283,680	4,820	1,302,960	4,820	1,302,960	0 "
75 MM Gun, M1	1,924,614 "	190,189	933,692 (Converted to 105's)				895,681	285,430 "
37 MM Gun, M4	574,485 "						320,338	254,147 "
37 MM AA Gun, M1, A2	517,945 "						211,940	306,005 "
57 MM Gun, M1	1,294,067 "						572,332	721,735 "
.50 Caliber	1,101,561 "	8,370,432					1,025,981	8,446,012 "
40 MM Gun	1,305,916 "	899,627					110,242	2,095,301 "
.45 Caliber Pistol	412,888 "	119,817					316,967	215,738 "
90 MM AA Gun	554,735 "	2,244,631					1,869,104	930,262 "
155 MM How. M1, M1917	60,086 "	1,247,702					1,307,788	0 "
20 MM Gun	0 "	207,440					7,500	199,940 "
7/8" Stick	0 "	2,823,553					1,369,708	1,453,845 "
3" Gun	0 "	45,817,666					35,708,346	10,109,320 "
.30 Caliber	0 "	273,413					73,790	199,623 "
50/50 Dry Pentolite	0 "	919,950					120,000	799,950 "
37 MM Gun, M3, M5, M6	0 "	1,442,143					21,600	1,420,543 "
3/8" Stick	0 "	131,040					120,960	10,080 "
Rolled, Trench Mortar	0 "	26,480	26,480		25,709		12,478	13,231 "
76 MM Gun	0 "	748,616					300,287	448,329 "
4.7 AA Gun Ign. Assembly	0 "		(Black) 10,050	20,100	10,050	20,100	10,050	0 "
Mixed Lot Remnants	1976 "	12,293					10,560	3,709 "
TOTALS	27,960,182 LBS 157,434 CHG	92,946,682	25,585,924	3,366,191	26,391,405	3,523,625	86,731,211	35,468,204 LBS.

Black: To Screen & Dry House 413,490 Lbs.
From Screen & Dry House 413,490 Lbs.

COMBINED TOTALS:

	230,779,842 Lbs. Net
Transferred without effecting inventory	2,227,356 Lbs. Net
	77,427,000 Lbs. Tare
	310,434,198 Lbs. Gross

POWDER HANDLED IN 1944 W.R.O.P.

TYPE POWDER	ON HAND 1-1-44	RECEIVED Lbs.	To LOADING LINES Lbs.	From LOADING LINES No. Charges	From LOADING LINES Weight - Lbs.	SHIPPED No. Charges	SHIPPED Charges & Bulk Weight - Lbs.	ON HAND 12-31-44
Black	156,605 Lbs	532,651	25,022		12,511		10,223	103,770 Lbs.
3" Gun	10,109,320 "	48,031,808					41,341,036	16,800,092 "
8" Gun, MK V-1	219,265 "						219,265	0 "
8" How. M1, M1 G.B.	273,780 "						273,780	0 "
8" How. M1, M2 W.B.	312,620 "						312,620	0 "
20 MM Gun	199,940 "						199,940	0 "
.30 Caliber	199,623 "	71,170					220,860	49,933 "
37 MM Gun, M4	254,147 "						155,639	98,508 "
37 MM Gun, M3, M5, M6	1,420,543 "	246,189					1,666,732	0 "
37 MM AA Gun, M1, A2	306,005 "						161,075	144,930 "
40 MM Gun	2,095,301 "						2,095,301	0 "
.45 Caliber Pistol	215,738 "	254,197					21,709	448,226 "
.50 Caliber	8,446,012 "						8,395,949	50,063 "
57 MM Gun, M1	721,735 "						361,300	360,435 "
75 MM Gun, M1	285,430 "	21,100					306,530	0 "
76 MM Gun	448,329 "	2,400,120					2,757,771	90,678 "
90 MM Gun, M1	0 "	1,218,194					1,190,937	27,257 "
90 MM AA Gun	930,262 "	1,467,744					2,393,176	4,830 "
105 MM How. M2 & M2A1	2,251,050 "	21,597,424	1,350,539	466,200	1,398,600	466,200	4,400,311	19,496,224 "
155 MM Gun, M1	3,817,058 "	2,633,244					5,419,931	1,030,371 "
155 MM How. M1, M3 G.B.	524,626 "						524,626	0 "
155 MM How. M1, M4	0 "	20,998,379	880,628	66,726	900,801	44,093	3,245,358	17,467,648 "
155 MM How. M1, M4 CHARGES	0 Chg							22,633 Chgs.
3/8" Stick	10,080 Lbs	114,092					124,172	0 Lbs.
7/8" Stick	1,453,845 "	1,762,795					3,167,220	49,420 "
Rolled, Trench Mortar	13,231 "	1,680,294	1,478,917		1,588,684		1,594,659	208,633 "
Flash Reducers, (T-1)	0 Chg	(Black)	562,127	560,454	503,708	530,404	476,700	30,050 Chgs.
50/50 Dry Pentolite	799,950 Lbs	1,260,650					2,060,600	0 Lbs.
Mixed Lot Remnants	3,709 "				2,519		3,809	2,419 "
TOTALS	35,468,204 LBS.	104,290,051	4,297,233	1,093,380	4,406,823	1,040,697	83,101,229	56,433,437 LBS. 52,683 CHGS.

Black: To Screen & Dry House 575,263 Lbs.
From Screen & Dry House 569,628 Lbs.

COMBINED TOTALS:

	197,240,227 Lbs. Net
Transferred without effecting inventory	7,059,024 Lbs. Net
	69,553,851 Lbs. Tare
	273,853,102 Lbs. Gross

POWDER HANDLED IN 1945 N.R.O.P.

TYPE POWDER	ON HAND 1-1-45	RECEIVED Lbs.	To LOADING LINES Lbs.	From LOADING LINES No. Charges	From LOADING LINES Weight - Lbs.	SHIPPED No. Charges	SHIPPED Charges & Bulk Weight - Lbs.	ON HAND 10-31-45
Black	103,770 Lbs	2,516,264	793,928		396,964		11,508	541,538 Lbs.
3" Gun	16,800,092 "	353,760					12,803,565	4,350,287 "
.30 Caliber	49,933 "						49,933	0 "
37 MM Gun, M4	98,508 "						98,508	0 "
37 MM AA Gun, M1, A2	144,930 "						144,930	0 "
.45 Caliber Pistol	448,226 "						76,894	371,332 "
.50 Caliber	50,063 "	40,050					90,113	0 "
57 MM Gun, M1	360,435 "	147,925					147,925	360,435 "
76 MM Gun	90,678 "						15,015	75,663 "
90 MM Gun, M1	27,257 "						27,257	0 "
90 MM AA Gun	4,830 "							4,830 "
105 MM How. M2 & M2A1	19,496,224 "	18,448,297	16,160,098		16,751,448		18,230,517	19,882,354 "
105 MM How. M2 & M2A1 CHARGES	0 Chgs	370,005 Cg		5,583,816		5,442,816		511,005 Chgs.
155 MM Gun, M1	1,030,371 Lbs.						1,030,371	0 Lbs.
155 MM How. M1, M4	17,467,648 "	23,225,967	24,917,020		25,369,956		27,523,913	11,950,865 "
155 MM How. M1, M4 CHARGES	22,633 Chgs			1,879,256		1,755,421		146,468 Chgs.
3/8" Stick	0 Lbs.	30,829					30,829	0 Lbs.
7/8" Stick	49,420 "							49,420 "
Rolled, Trench Mortar	208,633 "	2,087,030	2,048,384		2,126,161		2,242,115	131,325 "
Flash Reducer, T-1	30,050 Chgs	(Black)	1,629,467	1,813,037	1,629,467	1,823,037	1,638,454	20,050 Chgs.
Flash Reducer, T-2	0 "	"	34,050	90,800	34,050	10,000	3,750	80,800 "
Flash Reducer, T-3	0 "	"	10,613	42,450	10,613	7,500	1,875	34,950 "
Flash Reducer, T-4	0 "	"	1,312	21,000	1,312	20,000	1,249	1,000 "
10" Mortar	0 Lbs.	51,293	2,318					48,975 Lbs.
Fin Assembly for 10" Mortar	0 Chgs			200	2,310	200	2,310	0 Chgs.
50/50 Dry Pentolite	0 Lbs.	1,440,000					60,050	1,379,950 Lbs.
Mixed Lot Remnants	2,419 "				68,381		70,800	0 "
Cyclotol	0 "	1,900					1,900	0 "
TOTALS	56,433,437 LBS. 52,683 CHGS	48,343,315	45,597,190	9,430,559	46,390,662	9,058,974	64,303,781	39,146,974 LBS. 794,273 CHGS.

Black: To Screen & Dry House 2,066,988 Lbs.
From Screen & Dry House 2,155,286 Lbs.

COMBINED TOTALS:

	208,857,222 Lbs. Net
Transferred without effecting inventory	1,052,711 Lbs. Net
	104,153,735 Lbs. Tare
	314,063,668 Lbs. Gross

SUMMARY OF POWDER HANDLED N.R.O.P.

YEAR		RECEIVED	TO LINES	From LOADING LINES		SHIPPED		TRANSFERRED without affecting inventory-Lb	ON HAND at end of year	TOTAL LBS. HANDLED	
			Weight - Lbs	No. Charges	Weight - Lbs	No. Charges	Chgs. & Bulk Weight - Lbs			NET	GROSS
1941	Bulk Powder-lbs	13,201,012	3,326,575		57,410			58,000	9,931,847	22,547,497	27,660,238
	Charges			772,605	3,217,106	615,171	2,744,804		157,434		
1942	Bulk Powder-lbs	67,675,793	48,404,742		791,766		2,034,482	3,566,948	27,960,182	215,826,523	283,225,512
	Charges			7,172,194	47,468,162	7,172,194	47,468,162		157,434		
1943	Bulk Powder-lbs	92,946,682	25,605,915		442,917		60,275,662	2,098,580	35,468,204	233,007,198	310,434,198
	Charges			3,366,191	25,947,488	3,523,625	26,455,549				
1944	Bulk Powder-lbs	104,290,051	5,432,132		584,658		78,477,344	7,215,804	56,433,437	204,299,251	273,853,102
	Charges			1,093,380	4,391,793	1,040,697	4,623,885		52,683		
1945	Bulk Powder-lbs	48,343,315	45,660,153		465,345		20,434,970	2,089,069	39,146,974	211,487,617	314,063,668
	Charges	(370,005)		9,430,559	45,925,317	9,058,974	45,446,495		794,273		
	lbs	1,110,015									
TOTALS	Bulk Powder-lbs	326,456,853	128,429,517		2,342,096		161,222,458	15,028,401	39,146,974	887,168,086	1,209,236,718
	Charges	(370,005)		21,834,929	126,949,866	21,410,661	126,738,895		(794,273)		
	lbs	1,110,015							3,655,180		
GRAND TOTAL-lbs		327,566,868	128,429,517		129,291,962		287,961,353	15,028,401	42,802,154	887,168,086	1,209,236,718

8. Resume' of Activities for the Year 1945

a. Organization Changes

Changes in personnel consisted principally in the addition of employees to operate 3 shifts instead of 1. The supervisory force was increased by 3 magazine shift foremen, each responsible for operations on the shift to which he was assigned; and 1 magazine foreman, who was responsible for checking and inspecting all powder shipments and executing all relative documents. The clerical personnel was increased by 2 for about four months. The operating force reached a high of 273 men in March.

The magazine foreman, in charge of checking and inspecting powder shipments, previously served as the shipping clerk under the supervision of the Stores Department. When he was placed under the Magazine Area supervisor, his duties remained practically unchanged. After the checkers and inspectors who were in his charge were released, the house foremen became wholly accountable for checking and inspecting shipments. Thus, a wage savings of approximately $1,600 per month was accomplished.

b. Improvements in Methods of Operation

In a previous section -- "Operations and Procedure," it was pointed out that the working efficiently in supplying the Loading lines with powder could be greatly increased if enough conveyor equipment were available to place a complete conveyor setup in each Storage Building from which was being removed powder to supply the Loading lines. In July sufficient conveyor equipment was received. After several days of experimenting, it was determined that the time required to supply the Loading lines was reduced from an average of 6 hours to 3 hours per day. The same crew of workmen was used throughout the experiment. Data were taken while six different powder lots were in process at the Loading lines.

In June the department was able to put into effect an arrangement resulting in the elimination of one handling of smokeless powder at the incoming Loading Line Magazines and one handling of completed charges at the Line Shipping Magazines. The trailers, loaded with powder, were placed in an easily accessable position at the Incoming Magazines for Loading Line workmen to obtain their supply of powder directly from the trailers. Empty trailers were placed at the Shipping Magazines to receive the completed charges without unloading them into the Magazines. Previously the powder had been stored in the Incoming Magazines and later picked up by Loading Line workmen for transfer to the Operating Building. Completed charges had been stacked in the Shipping Magazines to be rehandled by Magazine Area men. Briefly, the arrangement eliminated the storage of powder in Line Magazines; based on the then current production requirements, an operation was eliminated which required the full time of eighteen workmen per day. The plan was wholly dependent upon having sufficient trucking equipment; because of curtailed schedules, the department had accumulated such equipment.

It will be noted in a subsequent paragraph that there were ninety-one units of automotive and trucking equipment in operation at one time. Since the equipment was in use on all three shifts and since not all of the tractors and trailers were coordinated to be used interchangeably, it was not unusual for as many as twelve different drivers to operate one unit of equipment within a period of twenty-four hours. The constant switching of drivers made it quite difficult to determine responsibility in occurrences of damage to the equipment. Eventually a set of forms were installed in each unit of equipment; each driver was required to record the date, starting mileage, condition of truck or tractor and trailer at the start and the stop, number of the trailer pulled, stopping mileage, and signature. A note at the foot of the form stated "If condition of truck is other than OK at any time, tear this sheet off and turn it in -- otherwise, turn in when completed." It was

necessary for the foremen to stop a driver occasionally to make sure that records were in order, but the drivers soon learned that the department could take just the records for a certain day and determine whether or not their complete time on duty was accounted for. The system immediately improved care of equipment and, as a result, damage soon became negligible.

During the period from January 1, 1945, to the close of operations, the department received, sent to and removed from the lines, and shipped a total gross of 313,588,437 lbs., including powder and tare weight. It required 267,308 man hours to accomplish the above. As has been pointed out, all of the above weight had to be lifted four different times.

c. Equipment -- Automotive and Trucking

The department from time to time obtained additional equipment until, at the maximum, the following units were being operated:

	Use
One Plymouth sedan	Supervisor
One Plymouth sedan	Department Foreman
One Plymouth station wagon	Department Foreman
One 1/2-ton pick-up	Department Foreman
One 1/2-ton pick-up	Clean-up man
One 1/2-ton pick-up	Materials for bracing cars
One 3/4-ton pick-up	Removing dunnage from cars
Four 1-1/2-ton stake-body trucks	Crew transport
One 29-33 passenger bus	Crew transport
One 1/2-ton weapon carrier	Crew transport
Two 3/4-ton carry-all	Crew transport
One 3/4-ton converted	Powder hauling
One 3-1/2-ton Mack-Diesel vans	Powder hauling
Three 5-ton Mack-Diesel vans	Powder hauling
Five 2-1/2-ton G.M.C. vans	Powder hauling
Six 2-1/2-ton Mack-Diesel tractors	Powder hauling
Four 5-ton (4-x-2 drive) Studebaker tractors	Powder hauling
Five 5-ton (6-x-4 drive) International tractors	Powder hauling
Twenty-five 5-ton Lapeer semi-trailers	Powder hauling
Twenty-six 11-ton semi-trailers	Powder hauling

Three of the above-listed powder-hauling and crew-transport trucks were used regularly to haul powder bags to and from the plant.

Considerable difficulty was experienced with the 11-ton semi-trailers. They had to be loaded and unloaded from the rear, the roads were not wide enough

to permit backing trailers at right angles to the loading platforms. The angle of approach was changed at two of the Magazine platforms in order to permit trailers to remain on hard-surface pavement after they had been backed into position for loading at platforms. In other instances, the hard surface was widened to sixty feet directly in front of Magazine platforms. Both changes were satisfactory in overcoming the difficulties.

The twenty-six 11-ton semi-trailers consisted of 12 Kentucky models and 14 Reliance models. The Reliance trailers were equipped with a landing gear that remained permanently fixed at right angles underneath the long axis of the trailer; the landing wheel supports receded into a tubing in much the same manner as the mechanism in a hydraulic jack does if the jack were placed upside down on the ground. The mechanism worked perfectly and gave no trouble. In contract the Kentucky trailers were equipped with a landing gear that folded underneath the bottom of the trailer. The arrangement was constantly giving trouble as a result of the gear's folding back after the trailer had been loaded and dropped. The front end of the trailer would then drop to the ground and had to be raised and repaired before being returned to service. The mishap could have been prevented in most cases if the driver had made certain that the landing gear was directly perpendicular with the ground before he removed the supporting tractor. The precaution required a great deal of time and labor, especially when the trailer was heavily loaded and road surfaces were not level and smooth.

d. Accident Experience

The record of lost-time injury was 3 injuries and 38 days lost for 275.144 man-hours exposure. Each of the injuries was sustained while men were handling powder, 2 being hand injuries and 1 a leg injury. The average frequency for minor injuries was 1 for each 1234 man-hours exposure. The total was 223 injuries, consisting principally of minor abrasions, slight

lacerations, and bruises. The average for minor injuries remained about the same for this last phase of operations as it was up until the end of 1944, but the lost-time injuries were reduced to less than one-third in frequency.

Chapter XXII

PLACING THE PLANT IN A SHUTDOWN CONDITION

1. Introduction

The New River Ordnance Plant was classified on August 29, 1945 as a surplus plant by the Ordnance Department. By order of the Field Director of Ammunition plants, this plant was prepared for acceptance by the Ordnance Department in a manner prescribed by the "Manual for Shutdown Procedure," approved by the contracting officer's representative and the operating manager, New River Ordnance Plant.

Except for preliminary cleaning of Explosives buildings conducted by operating personnel, all work pertaining to shutting down the plant was carried out under the supervision of the plant engineer. Inventories of Class "A" Property were made by operating supervisory personnel assigned to the Engineering Department for that purpose. These people were assisted in making the inventories by such Maintenance Department personnel as was required to identify specifically certain equipment, fittings, etc., in order that proper nomenclature could be applied and the location definitely determined.

2. Bag Manufacturing Department

When orders dated August 15, 1945 to shut the Bag Manufacturing Department down were received, many bags were in the process of being manufactured. Individual pieces had been cut and stored in anticipation of completing existing orders. In order that this supply could be counted and packed into storage containers, ten responsible employees were retained on the payroll. It required about four weeks to complete the sorting and packing of incompleted bag pieces.

As this work was in progress, records and files were consolidated and transferred to the New River General Files; office furniture and incidental supplies were returned to the Warehouse for credit; rolls of new cloth in

stock were measured, counted, and returned to the Warehouse. Maintenance parts and supplies for sewing machines, printing presses, cloth cutters, cloth spreaders, etc., were packed, identified, and returned to warehouse stock.

All operating equipment in the Sewing Room, Printing Room, and Cutting Room was disassembled, treated, and stored. Cloth bags were provided to cover sewing machines in storage. Dye Room equipment was treated, put in shutdown condition, and left in place. Disassembling, treating, and storing was done in accordance with approved shutdown procedure.

The Bag Manufacturing Building was cleaned; Class "A" Property was inventoried; and the building was accepted by Ordnance on November 28, 1945.

Laundry equipment was crated or boxed and shipped on instructions received from the Government. The Laundry Building was cleaned and a Class "A" Inventory was taken and accepted by Ordnance on November 20, 1945.

3. Bag Loading Departments

a. Smokeless Loading Department

With the termination of Loading Operations on each Loading Line, operating crews transferred all powder and charges from Operating buildings to the outgoing Magazine for shipment to the Magazine Area for storage. The buildings and surrounding areas were given a general cleaning, thereby placing the area in a safe condition for the Maintenance Department to carry out the shutdown procedure.

Buildings were inspected by the Fire Department personnel and permits were issued for dismantling equipment. Machinery and equipment was removed and cleaned by approved methods. Utilities were disconnected, cleaned, and put in shutdown condition. Each house was thoroughly washed and cleaned and the premises cleaned and flashed. Sprinkler systems were cut off and put in shutdown condition. After an inventory of Class "A" Property was made, the buildings were accepted by the Ordnance Department on November 13, 1945.

Records and files were consolidated and transferred to the New River General Files.

b. Black Powder Loading Department

The same general procedure was followed in shutting down the Black Powder Loading Department as was applied to the Smokeless Loading Department. After equipment was removed from the Black Powder Operating buildings, it was thoroughly washed with hot water and steam before further cleaning was done in order that possible contamination from black-powder dust would be eliminated.

The Flash Reducer Screen and Dry Unit was cleaned, dismantled, crated, and shipped on orders from Ordnance to Hoosier Ordnance Plant, Charlestown, Indiana.

Screen and Dry Unit No. 1 was cleaned, and the Screen Unit, Drive, etc., were stored in the Warehouse. The Dry Unit was disassembled, treated according to the shutdown procedure, and left in the Drier Building.

Class "A" Property was inventoried, and the buildings were accepted by the Ordnance Department on November 13, 1945.

Records and files were transferred to the New River General Files.

4. Magazine Department

The Magazine Office Building was vacated; the boilers and utilities were put in shutdown condition; Class "A" Property was inventoried; and the building was accepted by Ordnance on November 20, 1945.

Automotive equipment in excess of current needs was turned in -- thoroughly cleaned and declared excess to the transportation officer, Third Transportation Zone. The Loading Platform Area was flashed to remove the possibility of powder contamination.

Igloos, Magazines, Loading Platforms, and the Magazine Area Carpenter Shop remained as Operating buildings, and were accepted by Ordnance as such.

13. Accounting Department

The Accounting Department maintained its normal functions of supplying Radford Ordnance Accounting Department with statistical information until the contract was cancelled. Departmental Files were then consolidated with the New River General Files.

14. Warehouses and Staff Houses

Warehouses, Staff Houses, Garages, and the Boiler House were retained as Operating buildings. After Class "A" Property Inventory was taken, these buildings were accepted by the Ordnance Department on November 28, 1945.

15. Administration Buildings

The building which was formerly occupied by the Ordnance Department and which was vacant during the reactivated period of New River's operation was cleaned, inventoried, and accepted by Ordnance on November 27, 1945.

The Hercules Administration Building was inventoried for Class "A" Property and turned over to Ordnance at the time Hercules Powder Company relinquished control to the Ordnance Department of the New River Ordnance Plant on November 28, 1945.

16. Man-hours and Costs

A schedule of man-hours and costs incurred in closing the New River Ordnance Plant is found on the following page.

Administration Building-First Aid Station-Guard Headquarters. After conversion it was turned over to Ordnance as an Operating Building.

10. Fire Department

The Fire Department and Sanitation Service remained in force. The Fire Department Building and the incinerator were accepted by Ordnance as Operating buildings.

11. Safety Department

The Safety Department played an active part in placing the plant in a shutdown condition. Procedures and practices applied in cleaning Explosives buildings and areas were followed very carefully in an effort to point out the unusual hazards that might arise, and accordingly prevent unnecessary personal injuries and property damage.

A burner for flashing the areas adjacent to Explosives buildings was developed from an existing tar-pot heater. This burner permitted efficient heating of contaminated soil and gravel and at the same time gave ample protection to the operator.

All cases of injuries involving potential compensation claims were reviewed and properly reported to the insurance carrier in order that interests of both the employee and the employer would be protected.

Records and files of the department were ultimately placed with the New River General Files.

12. Planning and Control Department

The supervisor of the Planning and Control Department made certain that all outstanding orders for materials were cancelled after orders to cease operations had been received. An inventory of essential materials was made and production records were reconciled. Department Files were closed and placed in the New River General Files.

After installation of the First Aid Station at Building No. 201, the Hospital Building was cleaned and accepted by Ordnance on November 28, 1945.

7. Service Group Organizations

Miscellaneous organizations responsible directly to the service superintendent were shutdown as provided in the Shutdown Manual in the following manner:

Change Houses and lockers were cleaned and prepared in shutdown condition. Class "A" Property was inventoried and accepted with lockers in place by Ordnance.

Cafeteria equipment was moved to the Warehouse; the building was cleaned; and Class "A" Property was inventoried and accepted by Ordnance on November 13, 1945.

Property belonging to the New River Recreation Association was distributed to various charitable and civic organizations. Plant property used in the Recreation Building was packed and shipped as directed by Ordnance.

The Motor Pool Office and Gasoline Station were retained as Operating buildings and accepted as such.

Records pertaining to THE LOADING LINE, the plant paper, were transferred to the New River Files.

8. Personnel Department

All Personnel Files were transferred to the Radford Ordnance Works and, under supervision of the two remaining members of the Personnel Department, were consolidated to provide a complete informational file on each individual employee and applicant.

Furniture and identification equipment was stored in the Warehouse; Class "A" Property was inventoried; and the building was accepted by Ordnance on November 20, 1945.

9. Guard Force

The Guard Force remained intact throughout the life of the contract. Guard Headquarters, Building No. 201, was converted to a combination

Magazine Department records were placed in the New River General Files.

5. Engineering Department

Activities under supervision of the Engineering Department were, in general, maintained intact throughout the life of the contract as it applied to New River. Buildings in which divisions of the department functioned were retained as Operating buildings, and after Class "A" Property was inventoried they were accepted by Ordnance as such on dates shown below.

These buildings included:

	Accepted by Ordnance
Combined Shops	November 20, 1945
Electric Shop	November 27, 1945
Outside Maintenance Office and Shed	November 28, 1945
Boiler House	November 13, 1945
Water Treating and Sewage Disposal Plant	November 27, 1945
Pumping Station	November 13, 1945

6. Medical Department

The Medical Department remained intact throughout the life of the contract, although on a reduced scale.

In preparing the Hospital for shutdown, an inventory of Class "A" Property was made, and surplus furniture and office equipment was moved into storage at the Warehouse. The X-ray equipment and surplus medical supplies were crated, boxed, and shipped, upon receiving orders from the Ordnance Department.

Sufficient equipment and supplies were retained to equip a First Aid Room, installed in Building No. 201.

Individual medical records were consolidated and transferred to the Radford Plant for further consolidation with the New River Personnel Files. The consolidation of these files required the services of three people for six weeks.

Departmental files were placed in New River General Files.